TIMBER SUPPLY BRANCH

TIMBER SUPPLY REVIEW

Lillooet Timber Supply Area Analysis Report

January 2001

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Timber Supply Area
Analysis Report

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Preface

This report contains a timber supply analysis and socio-economic analysis and is part of the provincial Timber Supply Review carried out by the British Columbia Forest Service. The purpose of the review is to examine the short- and long-term effects of current forest management practices on the availability of timber for harvesting in timber supply areas (TSAs) and tree farm licences (TFLs) throughout British Columbia. A review of each TSA and TFL is completed at least once every five years.

To determine allowable timber harvesting levels, the Chief Forester must have an up-to-date assessment of the timber supply based on the best available information and reflecting current management direction. **The report that follows provides this assessment but should not be construed as a recommendation on permissible harvest levels.**

This report focuses on a single forest management scenario — current management practices. Current management practices are defined by the specifications in management plans for the timber supply area including guidelines for the protection of forest resources, the *Forest Practices Code (FPC) of B.C. Act* and official land-use decisions made by Cabinet.

Focussing the assessment on the implications of current practices rather than looking at a number of different management schemes expedites the analysis process, allowing analysis of all TSAs in the province every five years. An important part of these analyses is an assessment of how results might be affected by uncertainties — a process called sensitivity analysis. Together, the sensitivity analyses and the assessment of the effects of current forest management on the timber supply form a solid basis for discussions among stakeholders about alternative timber harvesting levels.

In addition to having an up-to-date assessment of timber supply when setting the allowable annual cut (AAC) the Chief Forester considers short- and long-term implications of alternative harvest levels, capabilities and requirements of existing and proposed processing facilities, and the social and economic objectives of the Crown. The socio-economic analysis provides the Chief Forester with some of the information necessary for these considerations.

Executive Summary

As part of the provincial Timber Supply Review, the British Columbia Forest Service has examined the availability of timber in the Lillooet Timber Supply Area (TSA). The analysis assesses how current forest management practices affect the supply of wood available for harvesting over both the short- (next 20 years) and long- (next 250 years) term. It also examines the potential changes in timber supply stemming from uncertainties about forest growth and management actions. **It is important to note that the various harvest forecasts included in the report indicate only the timber supply implications of current practices and uncertainty. As such, the forecasts should be used for discussion purposes only; they are not allowable annual cut (AAC) recommendations.**

The Lillooet TSA covers about 1 125 000 hectares of area in the south central interior of British Columbia. About 296 000 hectares are considered available for timber production and harvesting under current management practices. In the area available for timber harvesting, the greater part of the forest is dominated by lodgepole pine, Douglas-fir, spruce, and balsam. Smaller areas are dominated by western redcedar, hemlock and deciduous species. Lodgepole pine, Douglas-fir, and spruce are the tree species most commonly used by the forest industry in the area.

Current forest management practices follow the standards and legislation set out by the *Forest Practices Code*.

The results of this timber supply analysis suggest that the current harvest level attributable to the Lillooet TSA of 636 600 cubic metres per year (the current AAC of 643 500 cubic metres less the woodlot AAC of 6900 cubic metres) can be maintained for three decades. This short-term level is followed by a reduction in timber supply over the subsequent six decades to 368 000 cubic metres per year, which is maintained over the long term. In addition, the analysis examines the potential harvest of 25 000 cubic metres per year that are allocated to Pulpwood 16 from the Lillooet TSA.

These results reflect current knowledge and information on forest inventory, growth, and management. However, uncertainty exists about several factors important in defining timber supply. A series of sensitivity analyses show that these uncertainties can affect timber supply to varying degrees. The sensitivity analyses show that within the ranges examined uncertainties generally do not significantly affect short-term timber supply (next 20 years) as projected in the Lillooet TSA base case. The largest potential effects on projected harvests over the short term are associated with uncertainties in estimates of timber volumes in existing stands and green-up requirements that limit the amount of area that may be harvested.

If existing volumes are 10% lower than expected the current harvest could be maintained for a single decade. If only 20% (instead of 33%) of an area was permitted to be below green-up height, short-term timber supply would be reduced immediately. There is no indication that the allowable percentage of area below green-up has been overestimated for the Lillooet TSA. All other sensitivity analyses generally affect the harvest levels projected in the medium (21 to 100 years) and the long term (over 100 years from now).

An inventory audit conducted in 1997 showed that volume estimates for mature stands (over 60 years old) in the TSA based on inventory information were approximately 12% less than volumes derived from ground samples. Further investigation and sampling has shown that while differences between inventory-based and audit-based volume estimates on areas not considered available for timber production are statistically significant, volumes on areas considered available for timber production are not.

Executive Summary

Medium-term timber supply (21 to 100 years from now) is affected by many of the factors tested through sensitivity analysis. Since the long-term harvest level is about 43% lower than the starting harvest level, uncertainties that alter either the amount of existing volume or the ability to access existing volume (that is, forest cover requirements) during the first 100 years will affect medium-term timber supply. The medium term is most affected by changes in the timber harvesting land base, volumes from existing stands, minimum harvestable ages (MHA), the amount of area allowed below green-up height, forest cover requirements for management of visual quality, and old-growth site index estimates. The effects of changes to managed stand yields begin to occur in eighty years. Either increases or decreases to the size of the timber harvesting land base cause respective changes in the medium-term and long-term timber supply. As projected in the base case in the short term, changes in the amount of volume expected from existing stands can greatly affect the medium term. Management for visual quality occurs on approximately 24% of the timber harvesting land base. Increases or decreases to forest cover requirements for visual quality will affect both the medium- and long-term harvest forecast. In this instance however, a requirement for less area allowed below green-up, while decreasing short-term timber supply, can increase long-term supply due to a shifting of timber supply into the future.

If site index is underestimated in old-growth stands, as suggested by recent research, yields in the medium- and long-term could be significantly higher than in the base case harvest forecast. Evidence from the provincial *Old-Growth Site Index* (OGSI) project suggests that the estimated future productivity of sites currently occupied by old-growth stands has been underestimated. However, there is no local evidence to suggest that the productivity of existing second-growth stands that make up approximately 13% of the timber harvesting land base in the Lillooet TSA, has been underestimated. Results of sensitivity analyses assessing the potential impacts of OGSI site index adjustments show an increase in the long-term timber supply. This result should be viewed as a general indication of trends, since OGSI adjustments have not been calibrated for the Lillooet TSA.

Long-term (over 100 years from now) timber supply is affected by uncertainties in all the above factors with the exception of changes to existing stand volumes.

The *Lillooet Land and Resource Management Plan* (LRMP) process is ongoing, and official designation as a higher level plan by Cabinet is not expected prior to the AAC determination for the Lillooet TSA. Therefore, the impacts of eventual LRMP recommendations are unknown and could not be included as current management; nor was sensitivity analysis possible given the preliminary status of the LRMP. However, the chief forester will consider any available LRMP information when making his determination.

In conclusion, this analysis indicates that based on current inventory, growth and yield, and forest management information, timber harvests in the Lillooet TSA can be maintained at the current level for up to thirty years. The analysis indicates that uncertainties in several factors related to the current forest inventory and management regime could affect timber supply. However, with the exception of underestimating site indices for old-growth stands, there is no conclusive evidence to suggest that significant inaccuracies exist in the information used in this analysis. If the LRMP recommendations are known and/or approved, then possible changes to the land base and forest management practices as a result of the LRMP will be considered by the chief forester at the time of the AAC determination.

Evidence from the provincial *Old-Growth Site Index* (OGSI) project suggests that the estimated future productivity of sites currently occupied by old-growth stands has been underestimated. However, there is no evidence to suggest that the productivity of existing second-growth stands that make up approximately 13% of the timber harvesting land base in the Lillooet TSA, has been underestimated. Results of sensitivity analyses assessing the potential impacts of OGSI site index adjustments showed an increase in the long-term timber supply. This result needs to be viewed as only a general indication of trends, since OGSI adjustments were not calibrated for the Lillooet TSA.

Executive Summary

The socio-economic analysis for the Lillooet TSA indicates that while the current AAC is 643 500 cubic metres, between 1996 and 1999, the harvest level actually averaged 488 023 cubic metres per year. The actual harvesting supports a TSA total of approximately 328 person-years of direct employment. Residents of the Lillooet TSA account for approximately 90% of this direct employment. The Lillooet TSA forestry sector supports a total of 1,310 person-years of direct, indirect and induced employment across the province.

The base case harvest forecast indicates a stable timber supply in the short term. If harvests remain at the projected level, they will provide stability for employment within the Lillooet TSA and help to maintain processing activity in the south-central portion of the province.

Provincial government revenues associated with the TSA harvest level average approximately $13 million per year.

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Introduction

Timber supply* is the quantity of timber available for harvest over time. Timber supply is dynamic, not only because trees naturally grow and die, but also because conditions that affect tree growth, and the social and economic factors that affect the availability of trees for harvest, change through time.

Assessing the timber supply involves considering physical, biological, social and economic factors for all forest resource values, not just for timber. Physical factors include the land features of the area under study as well as the physical characteristics of living organisms, especially trees. Biological factors include the growth and development of living organisms. Economic factors include the financial profitability of conducting forest operations, and the broader community and social aspects of managing the forest resource.

All of these factors are linked: the financial profitability of harvest operations depends upon the terrain, as well as the physical characteristics of the trees to be harvested. Determining the physical characteristics of trees in the future requires knowledge of their growth. Decisions about whether a stand is available for harvest often depend on how its harvest could affect the growth and development of another part of the forest resource, such as wildlife or a recreation area.

These factors are also subject to both uncertainty and different points of view. Financial profitability may change as world timber markets change. Unforeseen losses due to fire or pest infestations will alter the amount and value of timber. The appropriate balance of timber and non-timber values in a forest is an ongoing subject of debate, and is complicated by changes in social objectives over time.

Thus, before an estimate of timber supply is interpreted, the set of physical, biological and socio-economic conditions on which it is based, and which define current forest management — as well as the uncertainties affecting these conditions — must first be understood. Timber supply analysis is the process of assessing and predicting the current and future timber supply for a management unit (a geographic area). For a timber supply area (TSA)*, the timber supply analysis forms part of the information used by the Chief Forester of British Columbia in determining an allowable annual cut (AAC)* — the permissible harvest level for the area.

Timber supply projections made for TSAs look far into the future — 250 years or more. However, because of the uncertainty surrounding the information and because forest management objectives change through time, these projections should not be viewed as static prescriptions that remain in place for that length of time. They remain relevant only as long as the information upon which they are based remains relevant. Thus, it is important that re-analysis occurs regularly, using new information and knowledge to update the timber supply picture. Indeed, the *Forest Act* requires that the timber supply for management units through British Columbia be reviewed at least every 5 years. This allows close monitoring of the timber supply and of the implications for the AAC stemming from changes in management practices and objectives.

**Throughout this document, an asterisk after a word or phrase indicates that it is defined in a box at the foot of the page, as well as in the glossary.*

Timber supply
The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)
An integrated resource management unit established in accordance with Section 7 of the Forest Act.

Allowable annual cut (AAC)
The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.

Introduction

Timber supply analysis involves three main steps. The first is collecting and preparing information and data. The B.C. Forest Service forest inventory* plays a major role in this. The second step is using this data along with a timber supply computer model or models to make projections or estimates of possible harvest levels over time. These projections are made using different sets of assumed values or conditions for the factors discussed above. The third step is interpreting and reporting results.

The following sections outline the timber supply analysis for the Lillooet TSA. Following a brief description of the area in Section 1, data preparation and formulation of assumptions are discussed in Section 2. Timber supply analysis methodology and results are presented in Sections 3 and 4. Section 5 examines the sensitivity of the results to uncertainties in the data and assumptions used. This is followed by a summary and conclusions for the timber supply analysis. Section 7 shows results of a socio-economic analysis for the Lillooet TSA. Appendixes A and B contain further details about the data and assumptions used in the analysis.

As part of the timber supply review (TSR), information is gathered on the short- and long-term implications of alternative harvest levels, and the capabilities and requirements of existing and proposed processing facilities. The socio-economic analysis provides information for the Chief Forester and the local community to better understand the potential magnitude of impacts associated with any proposed harvest level changes.

The socio-economic analysis considers the current and projected levels of forestry activity associated with the Lillooet TSA within the context of regional timber supplies and production capacity. It does this by examining the profile of the region and the local forest industry; and by assessing employment and income implications of timber harvesting level projected in the base case.

The socio-economic analysis includes an estimate of the employment and income impacts associated with timber supply analysis projections by three main sectors: harvesting and other woodlands related activity, processing, and silviculture. Employment is measured in person-years*. Employment income is calculated using average industry income estimates.

Forest inventory
An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.

Person-year(s)
One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.

Introduction

Data on direct employment, harvest levels, and fibre flows was obtained by surveying licensees and mill operators. The information was used to estimate harvesting, processing and silviculture direct employment averages associated with the harvest and the proportion of workers living in the area. The estimates of local and provincial harvesting, processing, and silviculture direct employment were then used to determine ratios of employment per 1000 cubic metres of timber harvested.

Indirect and induced* employment figures were calculated using the Lillooet TSA and provincial employment multipliers* developed by the Ministry of Finance and Corporate Relations. Indirect impacts result from direct businesses purchasing goods and services; induced impacts result from direct employees purchasing goods and services. Employment coefficients* per 1000 cubic metres were also determined for the indirect and induced impacts.

To estimate the level of employment that could be supported by alternative harvest rates, projected timber supply levels were multiplied by the calculated employment coefficients. It should be noted that employment coefficients are based on current productivity, harvest practices and management assumptions* and will not likely reflect industry conditions decades into the future. As such, the employment estimates can only be viewed as general indicators.

Employment multiplier
An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

Employment coefficient
The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

Indirect and induced jobs
Indirect jobs are supported by direct business purchases of goods and services. Induced jobs are supported by employee purchases of goods and services; for example, at retail outlets.

Management assumptions
Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.

1 Description of the Lillooet Timber Supply Area

The Lillooet Timber Supply Area (TSA) is situated in southwestern British Columbia and covers approximately 1.125 million hectares. Located in the western portion of the Kamloops Forest Region, the TSA is administered from the Lillooet forest district office in Lillooet. The TSA boundaries are the same as those of the Lillooet Forest District, which also includes several provincial parks (Stein Valley Nlaka'Pamux Heritage Park, Duffy Lake Park, Marble Canyon Park, Skihist Park and Goldpan Park).

The main community in the Lillooet TSA is Lillooet which is home to about half of the TSA's population of approximately 6,538 (1996 census). Lytton is the other main community, and smaller centres include Xaxli'p, Shalath, Spences Bridge, Bralorne and Gold Bridge.

The climate and ecology of the Lillooet TSA are very diverse because of the mountainous terrain, including the Pacific Ranges in the west, the southern Chilcotin Ranges in the north and the Pavilion Ranges in the east. The western portion of the TSA is located on the eastern slopes of the Coast Mountain range and is transitional from wet coastal conditions to drier interior conditions. The eastern portion of the TSA grades toward the Thompson-Okanagan plateau and has the characteristic low rainfall of the interior dry-belt. The TSA encompasses several river systems that drain into the Fraser River, including the Stein and Bridge rivers.

The forests of the Lillooet TSA are fairly diverse. Within the land base currently considered available for timber harvesting, lodgepole pine and Douglas-fir predominate, while spruce, subalpine fir, western redcedar and western hemlock also occur. The current allowable annual cut (AAC) in the Lillooet TSA is 643 500 cubic metres, which includes 6900 cubic metres attributable to woodlots. This level was set by the chief forester on June 20, 1996, and was unchanged from the previous determination. Since woodlots are administered separately from the TSA, the harvest level associated with the TSA is 636 600 cubic metres. About 45% of the TSA land base is considered productive forest land managed by the B.C. Forest Service (approximately 506 000 hectares). Currently about 59% of this forested land base is considered available for harvesting (26% of the total TSA land base).

Significant changes that influence forest management have occurred since the last timber supply review was completed. These changes include:

- implementation of the Forest Practices Code*;
- completion of terrain stability mapping for about one-half the TSA;
- updated estimates of the area in riparian buffers.

The Lillooet land and resource management planning (LRMP) process began in 1995 and includes the Lillooet Forest District. The process provides an opportunity for the public, First Nations, interest groups and government to make recommendations regarding protected areas* and future management of public forest and aquatic resources in the planning area. If the LRMP is completed and approved by government prior to setting the AAC, the chief forester will consider those parts of the plan that are relevant to timber supply.

Forest Practices Code
Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.

Protected area
A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).

1 Description of the Lillooet Timber Supply Area

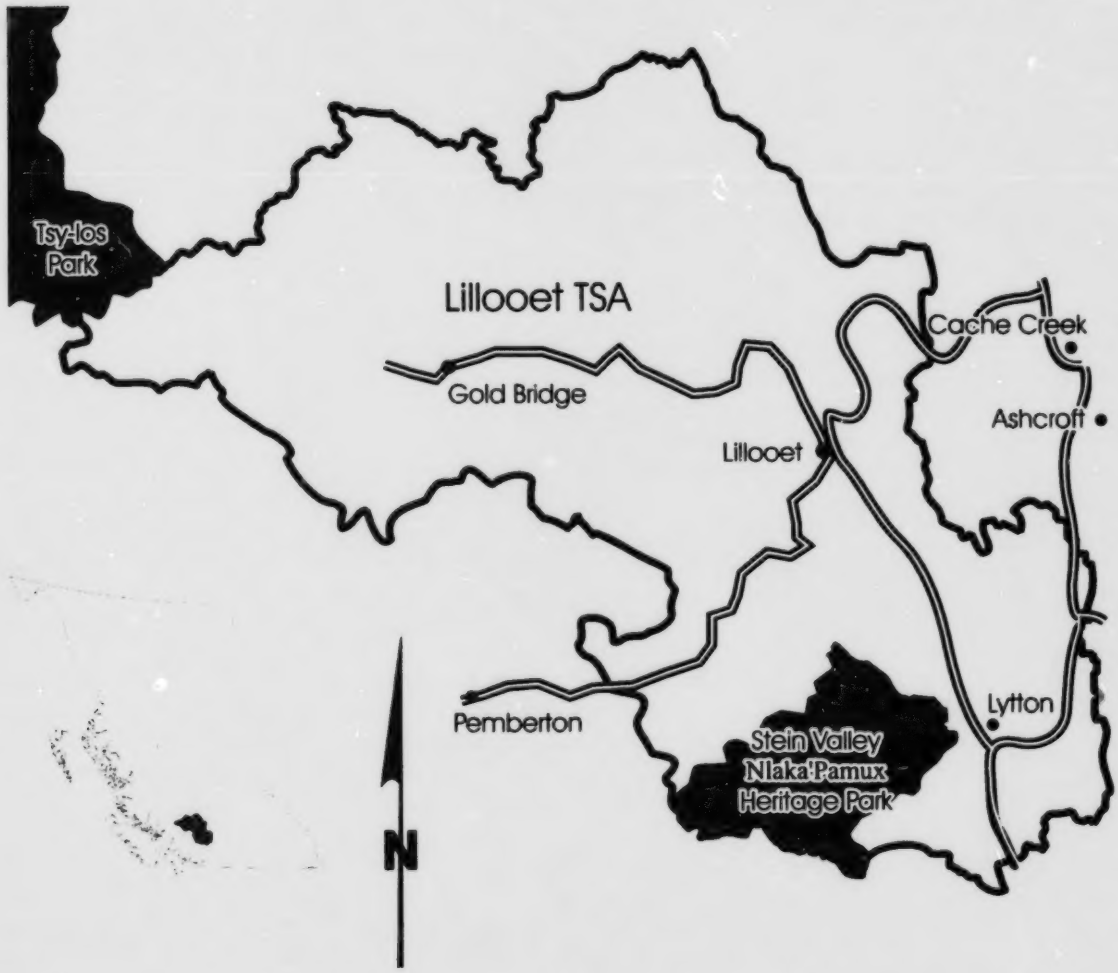


Figure 1. Map of the Lillooet Timber Supply Area, Kamloops Forest Region.

1 Description of the Lillooet Timber Supply Area

Pulpwood Agreement (PA) 16 covers parts of the Lillooet as well as the Williams Lake, 100 Mile House, Kamloops TSAs. Under the PA, 25 000 cubic metres per year of pulp quality timber can be harvested within the Lillooet TSA; however specific harvesting attributable to PA has yet to occur in the TSA. Approximately 15 years remain until expiry of agreement, and it is expected that given the current distribution of harvest across the four TSAs that contribute to the PA, there will soon be harvest activity in the Lillooet TSA.

The forests of the Lillooet TSA provide a wide range of forest land resources, including timber, forage, mining, wildlife and tourism amenities. Outdoor recreational values and uses of the forests are high due to the proximity of several provincial parks and the exceptional natural scenery. Both residents and tourists enjoy fishing, hunting, mountain-biking, hiking, camping, boating, river rafting, horseback riding, heli-skiing, cross-country skiing and snowmobiling.

1.1 The environment

The seven biogeoclimatic zones* in the Lillooet TSA range from dry grassland valley bottoms and the semi-desert in the eastern part of the TSA, to coniferous* forests at middle and high elevations, and alpine tundra on ridges and mountain tops. The varied ecological features and unique nature of the area contribute to the high biodiversity* values found in this TSA.

The Bunchgrass (BG) zone has limited occurrence at the lowest elevations of the Fraser and Thompson river valleys. This zone is characterized by warm to hot, dry summers and moderately cold winters with relatively little snowfall. Tree establishment is restricted by the climate, and grasslands predominate. Although not significant as a source of harvestable timber, the BG zone is important for agriculture, ranching and biodiversity. The BG zone is one of the smallest in B.C., but it supports a wide range of wildlife, including many species that are of provincial or national significance because of their rarity or uniqueness.

The Ponderosa Pine (PP) zone occupies low elevations along the very dry valleys of the Fraser and Thompson rivers. This zone is characterized by low annual precipitation, very warm summers and cool winters. Open, park-like stands of ponderosa pine with a grassy understory dominate the PP zone, making it of limited commercial value for forestry. However it is important for cattle grazing particularly in early spring and late fall.

The Interior Douglas-fir (IDF) zone dominates the lower to middle elevations of the Lillooet TSA, generally occurring above the PP zone and below the Montane Spruce zone. The IDF zone has warm, dry summers and cool winters, allowing a long growing season. Douglas-fir is the most common tree species, with ponderosa pine found at lower elevations, white spruce at higher elevations and lodgepole pine throughout. Forestry is a very important resource use in this zone, as is cattle grazing.

The Coastal Western Hemlock (CWH) zone also occurs at low to middle elevations along the slopes of the Coast Mountains. It is the wettest zone in the province, with cool summers and mild winters. The dominant trees are western hemlock and western redcedar.

Biogeoclimatic zones
A large geographic area with broadly homogeneous climate and similar dominant tree species.
Coniferous
Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.

Biodiversity (biological diversity)
The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.

The Montane Spruce (MS) zone occurs at middle elevations, generally above the IDF zone and below the Engelmann Spruce-Subalpine Fir zone. The climate of this zone is continental, with cold winters and moderately short, warm summers. The dominant tree species are hybrid white spruce, subalpine fir and lodgepole pine. Forestry, cattle grazing and fur trapping are important resource uses in this zone.

The Engelmann Spruce-Subalpine Fir (ESSF) zone is the uppermost forested zone in the Lillooet TSA, typically occurring above the MS and CWH zones and below the Alpine Tundra zone. The ESSF has a relatively cold, moist and snowy continental climate. Growing seasons are cool and short, while winters are long and cold. Engelmann spruce and subalpine fir are the dominant climax tree species, while lodgepole pine is common after fires. At lower elevations, western white pine, Douglas-fir, western hemlock and western redcedar can be found. Timber and fur bearers are important resources.

The Alpine Tundra (AT) zone occurs at high elevations above the ESSF zone. The climate is cold, windy and snowy with a short, cool growing season. By definition this zone is treeless and vegetation is dominated by shrubs, herbs, mosses and lichens. Much of the alpine landscape lacks vegetation and is the domain of rock, ice and snow.

A wide variety of wildlife species inhabit the diverse forests of the Lillooet TSA, including large mammals such as moose, elk, mule deer, bighorn sheep, mountain goats and grizzly bear. All these animals move throughout the TSA, generally using different ranges in summer than in winter so migration corridors between seasonal ranges are important. Small mammals and birds are also abundant.

The *Forest Practices Code* includes a process for identifying species at risk and designating wildlife habitat areas with specific management practices. The wildlife species that have been identified in Volume 1 of the provincial *Identified Wildlife Management Strategy* in the six main ecosections of the Lillooet Forest District are presented in Table 1. The first four ecosections (Leeward Pacific, Pavilion, South Chilcotin Ranges and Central Chilcotin Ranges) occupy about 90% of the TSA.

1 Description of the Lillooet Timber Supply Area

Table 1. Species declared as identified wildlife under the Forest Practices Code (February 1999)

Common names of identified wildlife	Ecosection					
	Leeward Pacific Ranges	Pavilion Ranges	South Chilcotin Ranges	Central Chilcotin Ranges	Fraser River Basin	Thompson Basin
Bull trout	x	x	x	x	x	x
Tailed frog	x		x			
Rubber boa	x	x	x		x	x
Racer	x	x	x			x
Gopher snake *deserticola*	x	x	x			x
American bittern		x			x	
Northern goshawk *atricapillus*	x	x	x	x	x	x
Prairie falcon	x	x	x	x	x	x
Long-billed curlew		x			x	x
Lewis's woodpecker		x			x	x
Brewer's sparrow *breweri*		x			x	x
Mountain beaver	x	x				
Fisher	x	x	x	x	x	
Grizzly bear	x	x	x	x		
Mountain goat	x		x	x		
Bighorn sheep *californiana*		x	x	x		x

Source: *Managing Identified Wildlife*, Volume 1, February 1999.

Water is a primary and fundamental resource of the Lillooet TSA. Whether occurring as surface or groundwater, it is a crucial component of the ecosystems found in the TSA. As well, the rivers, lakes and streams of the TSA support populations of pink salmon, coho, sockeye, steelhead, chinook, rainbow trout, whitefish, bull trout, kokanee and white sturgeon.

Current forest management practices follow the legislation and guidelines set out by the *Forest Practices Code*. Consequently, the protection of wildlife and the environment will be managed through the *Code*. As stated previously, the *Lillooet LRMP*, once approved by government and implemented, will also provide further management direction for public forest lands in the Lillooet TSA, as well as for wildlife species not included in the above list.

1.2 First Nations

The First Nations in the Lillooet TSA are represented by eight tribal associations who are responsible for strategic planning, economic development and co-ordination of information regarding the lands traditionally claimed by the four First Nations: St'at'imc, N'lakapamux, Secwepmc and T'silquotin.

Twelve First Nation communities are found within the TSA, mainly along the Fraser and Thompson rivers and Seton Lake, near to Lillooet and Lytton. The communities having reserve lands within the TSA are: Lytton First Nation, Fountain Indian Band, Seton Lake Band, Pavilion Indian Band, Bridge River Indian Band, T'it'q'et (Lillooet) Indian Band, Cook's Ferry Indian Band, Siska Indian Band, Kanaka Bar Band, Cayoose Creek Indian Band, Nicomen Indian Band and Skuppah Indian Band. In addition, First Nations with reserves outside the Lillooet TSA have significant land-based interests within the TSA. These include the Esketemc (Alkali), N'Quatqua, Ashcroft, Canoe Creek, High Bar, Mount Currie, Oregon Jack and Whispering Pines Indian Bands.

The Lillooet TSA is unique because of the high density of known and predicted archaeological sites. An Archaeological Overview Assessment (AOA) has been completed for the TSA, which identifies areas with potential for archaeological sites. If sites of potential archaeological importance are discovered during operational planning, consideration will be given to designing management practices appropriate for their protection.

The Xaxli'p First Nation (Fountain Band) is currently engaged in the B.C. Treaty Process and Treaty Settlement Lands could potentially be negotiated within the Lillooet TSA in 2001.

While the points of views and cultures of First Nations people in the Lillooet TSA are quite diverse, some common themes are apparent. Many First Nation communities within the Lillooet TSA have expressed a desire to play a greater role in the forest economy in keeping with their beliefs as aboriginal peoples. For some First Nations people achieving balance between industry demands, and forestry practices that take into account good environmental stewardship is fundamental to their participation in forestry.

2 Information Preparation for the Timber Supply Analysis

Timber supply analysis requires three general categories of information: land base inventory; timber growth and yield; and management practices. These three categories are discussed below. Also, in preparation for the analysis, a number of changes since the 1994 Lillooet TSA timber supply analysis were noted, and are described in Section 2.4, "Changes since the 1995 Lillooet TSA analysis."

2.1 Land base inventory

Land base information used in this analysis came in the form of a computer file compiled in 1997 by the B.C. Forest Service. This file contains information on the forest land in the Lillooet TSA including general geographic location, area, nature of forest cover (such as presence or absence of trees, species, number of trees, age, and timber volume), and other characteristics such as environmental sensitivity and physical accessibility (operability*). Stand attributes such as tree height, stocking* and age have been projected to January 1997. The inventory file has been updated to account for timber harvesting up to December 1996.

The inventory file represents the land base for the entire TSA. It includes information on land that does not contain forest, and other areas where timber harvesting is not expected to occur. Examples are land set aside for parks, areas needed to protect wildlife habitat, areas in utility and transportation corridors, and residential and industrial development. A description of these areas specific to the Lillooet TSA is provided below. These types of areas do not contribute to the timber harvesting land base* of the Lillooet TSA. Before assessing timber supply, these non-contributing areas are identified and separated from the timber harvesting land base. When deriving this data file, care is taken to make only a single reduction for areas that overlap (for example, where an inoperable area is also wildlife habitat).

Identifying areas as not contributing to timber supply does not mean the area is removed from the Lillooet TSA. The B.C. Forest Service still manages the entire area of the TSA (except for designated areas under the jurisdiction of other agencies) as a land unit that contributes a mix of timber and non-timber values. The timber supply is managed within this integrated resource context, and the analysis described here is consistent with this philosophy.

This section describes the types of areas not contributing to the timber harvesting land base. Use of the term timber harvesting land base in this report does not mean the area is open to unrestricted logging. Rather, it implies that forests in the area contain accessible timber of sufficient economic value — and sites of adequate environmental resilience — to accommodate timber harvesting with due care for other resources.

For the Lillooet TSA, the following types of areas were excluded from the timber harvesting land base.

- not managed by the B.C. Forest Service — these are non-Crown areas, such as private land and Indian Reserves, and parks removed from the productive forest. Parks and ecological reserves contribute towards biodiversity values.
- non-forest areas — areas not occupied by productive forest cover (e.g., rock, swamp, alpine areas and water bodies).
- non-commercial cover areas — areas occupied by non-commercial tree or brush species.

Operability
Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.

Stocking
The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.

Timber harvesting land base
Crown forest land within the timber supply area that is currently considered feasible and economical for timber harvesting.

- inoperable areas* — areas classified as unavailable for harvest for terrain-related reasons.
- environmentally sensitive and terrain class V areas — areas with sensitive soils, high recreation values, and avalanche hazards were excluded.
- sites with low timber productivity — areas occupied by forest with low timber-growing potential.
- non-merchantable forest types* — stands which are physically operable and exceed low site criteria yet are not currently utilized or have marginal merchantability, including deciduous*-leading stands.
- community watershed intakes — area excluded around each intake in defined community watershed.
- existing roads, trails and landings (RTL) — areas of forest land that have been removed from timber production due to access development and harvesting to date.
- riparian reserve zone area — area otherwise available for timber production, a portion of which is assumed to be unavailable for harvesting to provide protection for riparian and stream ecosystems.
- wildlife tree* patch areas — areas reserved within and along the edges of cutblocks* for the maintenance of stand-level biodiversity* (stand structure), primarily for conservation or enhancement of wildlife. For the analysis, these areas were represented with reductions to stand yields, not area exclusion due to their small size.

A more detailed description of these categories, including specific criteria for removal is located in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Table 2 summarizes the areas in each category, and shows the area of the timber harvesting land base.

The current timber harvesting land base in the Lillooet TSA represents about 26.3% of the total TSA area and about 58.6% of the productive forest. Most of the excluded area is in three categories: inoperable areas (19.5% of the productive forest), environmentally sensitive and terrain class V areas (10.4%) and low sites (7.6%). The remaining categories, such as riparian areas*, represent 5.6% of the productive forest. The percentages provided depend on the order in which each category is considered. For instance, riparian areas would constitute a larger proportion of the reduction if they were considered prior to inoperable areas.

Inoperable areas
Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.
Non-merchantable forest types
Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.
Deciduous
Deciduous trees commonly have broad-leaves and usually shed their leaves annually.

Wildlife tree
A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.
Cutblock
A specific area, with defined boundaries, authorized for harvest.
Stand-level biodiversity
A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Riparian area
Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.

2 Information Preparation for the Timber Supply Analysis

Table 2. Determination of the timber harvesting land base for the Lillooet TSA

Classification	Area (hectares)	Per cent (%) of total area	Per cent (%) of Crown forest area
Total area	1 125 187	100.0	
Not managed by B.C. Forest Service	166 260	14.8	
Non-forest	452 993	40.3	
Total productive forest land	505 933[a]	45.0	100.0
Non-commercial brush	532	0.0	0.1
Inoperable	98 506	8.8	19.5
Terrain class V	9 894	0.9	2.0
Environmentally sensitive	42 359	3.8	8.4
Sites with low timber growing potential	38 682	3.4	7.6
Non-merchantable stands	4 870	0.4	1.0
Community watershed intakes	0[b]	0.0	0.0
Riparian	6 598	0.6	1.3
Existing roads	8 183	0.7	1.6
Total current reductions	209 623	18.6	41.4
Initial timber harvesting land base	296 311	26.3	58.6
Future roads	13 793		
Future timber harvesting land base	282 518		

(a) The total Crown forested land base in the Lillooet analysis area, which includes some protected areas not managed by the B.C. Forest Service, is approximately 545 000 hectares. Although this area is not managed for timber supply, the forest contributes to non-timber objectives such requirements for old-seral forest to maintain biodiversity.

(b) A semi-circular non-harvest reserve of 1.47 hectares is left above each intake in community watersheds. However, due to overlaps with other exclusions, the area excluded specifically for intakes was negligible.

2 Information Preparation for the Timber Supply Analysis

Figure 2 represents both the total Lillooet TSA area, and the productive forest land base. The total area chart shows that about 14.8% of the total land base is classified as not managed by B.C. Forest Service, and 40.3% is classified as non-forest or non-productive forest (i.e., having very few trees).

The productive forest chart details the categories of forest land and shows that about 58.6% of the forest land in the Lillooet TSA is considered to be available for timber harvesting (including not satisfactorily restocked (NSR)*).

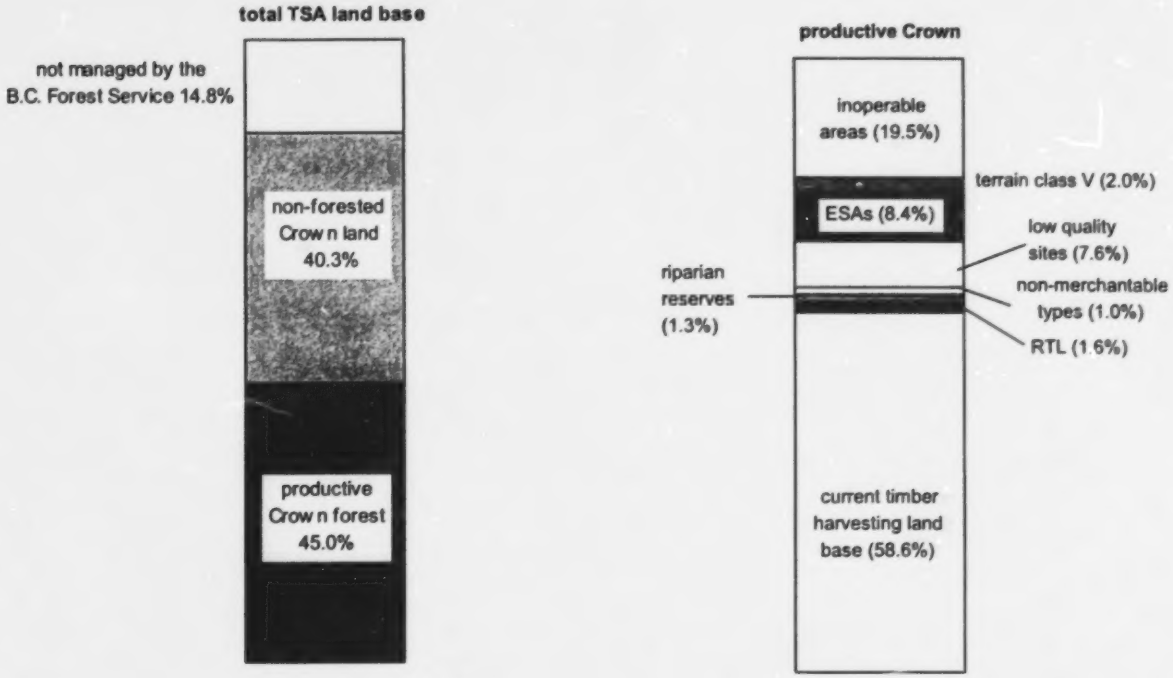


Figure 2. Composition of the total and productive forest land bases — Lillooet TSA, 2001.

Not satisfactorily restocked (NSR) areas
An area not covered by a sufficient number of well spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.

2 Information Preparation for the Timber Supply Analysis

Figure 3 shows the current composition of the timber harvesting land base by dominant tree species. Lodgepole pine dominates 41.5% of the area of stands within the timber harvesting land base, with Douglas-fir species on moister sites dominating 30.9%. Douglas-fir species on drier sites, where selection harvesting is expected, dominate 9.6% of the timber harvesting land base. While stands leading in spruce, balsam, cedar, and hemlock are prevalent on 17.9% of the area, the area of timber harvesting land base with cedar and hemlock-leading stands is only 0.1%. Deciduous stands expected to be harvested under Pulpwood Agreement (PA)* 16 make up 0.1% of the timber harvesting land base. After harvest, most stands are expected to be regenerated to stands as described in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis."

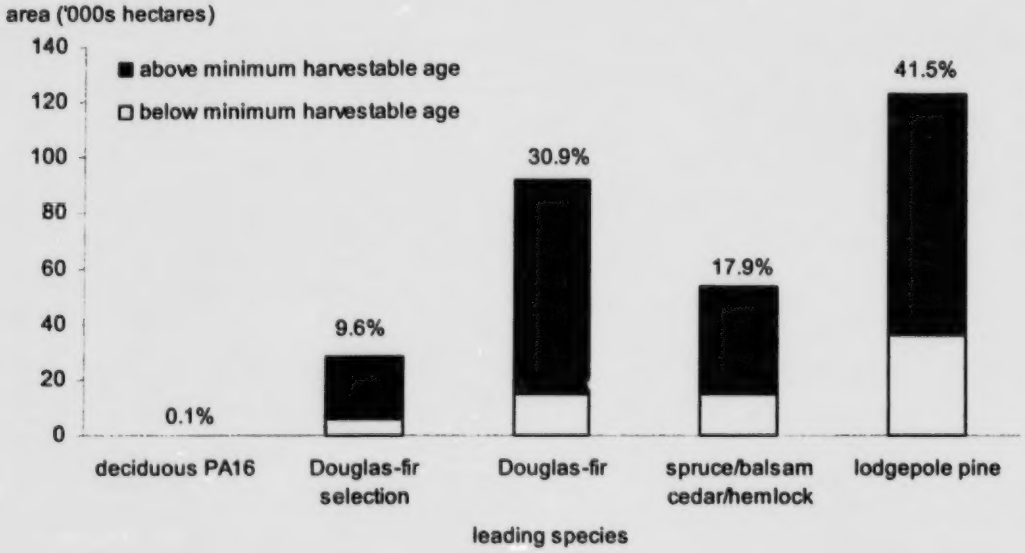


Figure 3. Area by dominant species — Lillooet TSA timber harvesting land base, 2001.

Figure 3 also shows the proportion of area of each species that is either younger or older than the minimum harvestable age for existing forests (see Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" for details on the minimum harvestable age for each species). In total, about 76% of stands in the timber harvesting land base are at or above the minimum harvestable age. This proportion varies among the species groupings: 71% of lodgepole pine stands, 84% of moister Douglas-fir stands, 72% of spruce, balsam, cedar, hemlock stands and 79% drier Douglas-fir stands are currently older than the minimum harvestable age.

Pulpwood agreements
An agreement applying to a fixed geographic area that allows harvesting of timber below sawlog standards if mill residues suitable for the facility under the agreement are not available.

Figure 4 provides an overview of the distribution of site productivity of the dominant stand types within the timber harvesting land base. The site classes in Figure 4 are groupings of site index* (metres in height at age 50 years). Sixty per cent of the stands are in the 'Poor' site class, while stands with a site class value of 'Medium' occupy 34% of the area, and those with a site class value of 'Good', cover 6% of the timber harvesting land base. The area-weighted average site index for the timber harvesting land base is 12.5. For stands older than 140 years of age, the area-weighted average site index is 11.4.

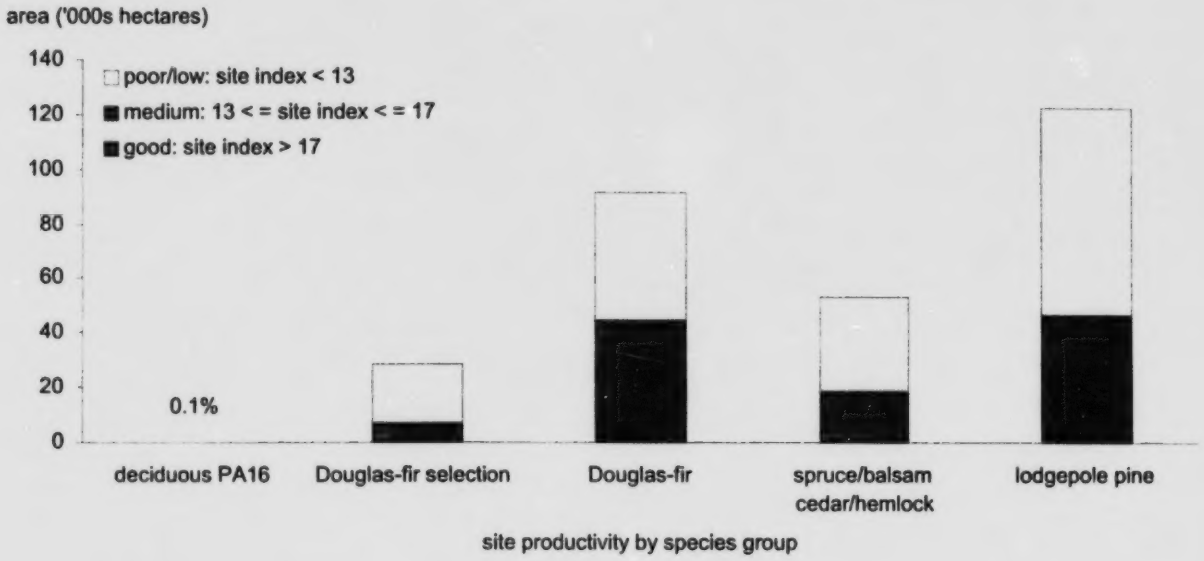


Figure 4. Area by site class — Lillooet TSA timber harvesting land base, 2001.

Site index
A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.

Figure 5 shows the current age composition of forested stands in the Lillooet TSA. About 5% of the timber harvesting land base is occupied by stands older than 250 years. About 13% of the area is covered with stands 20 years or younger, 20% is between 21 and 100 years old, and 62% is between 101 and 250 years of age. Almost 76% of the timber harvesting land base is covered with stands at or above the minimum harvestable age applicable to the stand.

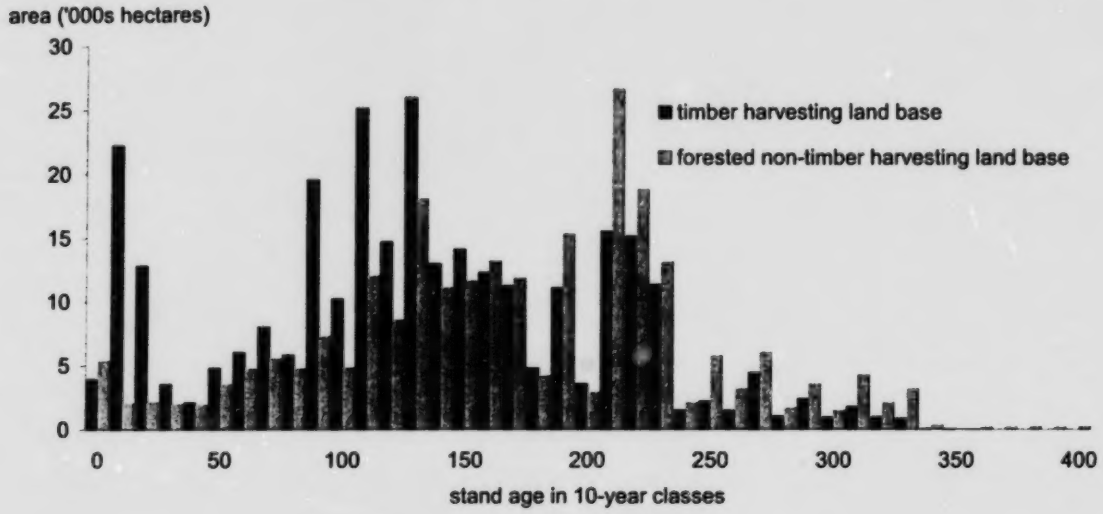


Figure 5. Current age class composition — Lillooet TSA productive forest land base, 2001.

The age class distribution of forested stands excluded from the timber harvesting land base also affects timber supply. Although they do not contribute directly to timber supply, these areas can affect how much harvesting can be conducted and the pattern of the harvesting within the TSA by providing old-forest and biodiversity attributes. The total Crown forested land base in the Lillooet analysis area, which includes some land not managed by the B.C. Forest Service, is approximately 545 000 hectares. A significant portion of the total forest area — 46% — does not contribute to the timber harvesting land base. About 11% of these "non-timber harvesting land base" stands are older than 250 years. Only 4% of the stands are 20 years or younger, 14% are between 21 and 100 years old, and 71% are between 101 and 250 years of age.

In the longer term, the non-timber harvesting land base will be able to provide almost all of the area needed to meet old-forest biodiversity requirements as set out in the *Landscape Unit Planning Guide* (LUPG). However, some old-forest timber harvesting land base will have to be reserved from harvesting into the medium-term while forests in the non-timber harvesting land base age sufficiently to achieve old-forest conditions.

2.2 Timber growth and yield

Two growth and yield models were used to estimate timber volumes for the Lillooet TSA analysis. The variable density yield prediction (VDYP)* model developed by the B.C. Forest Service, Resources Inventory Branch, was used for estimating volumes in unmanaged coniferous and deciduous stands. Managed deciduous stand volumes were also assigned using VDYP volume estimates*. The table interpolation program for stand yields (TIPSY), developed by the B.C. Forest Service, Research Branch, was used to estimate yields for coniferous managed stands. TIPSY was also used to estimate yields from stands that were harvested in the past but managed to current standards. Depending on the species, these stands may be as old as 41 years of age.

Timber volume estimates assume a specific utilization level, or set of dimensions, which establish the minimum sizes of trees and logs that are removed from a site. Utilization levels used in estimating timber volumes specify minimum diameters both near the base and the top of a tree as well as a maximum stump height.

Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" contains details on the definition of managed stands, utilization standards and the specific model* versions used.

Volume estimation and prediction are subject to uncertainty due to uncertainties in inventories which form the basis for estimating site productivity, limited experience with second-growth in British Columbia, and the long time frame over which trees grow. Sensitivity analyses described in Section 5, "Timber Supply Sensitivity Analyses," address the possibility that actual timber volumes may be different from estimates used in this analysis.

Based on timber volume estimates, the current timber inventory on the timber harvesting land base is approximately 40 million cubic metres. About 39 million cubic metres, or 98%, of the total, is currently merchantable; that is, older than minimum harvestable age.

Volume estimates (yield projections)
Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.

Model
An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.

Variable Density Yield Prediction model
A B.C. Forest Service computer program that generates natural stand yields.

2.3 Management practices

Timber supply depends directly on how the forest is managed for both timber and non-timber values. Therefore, levels of management activity must be defined for the timber supply analysis. The *Forest Practices Code of British Columbia Act* and associated regulations guide forest management practices in the Lillooet TSA. The focus of the Timber Supply Review is to assess timber supply based on current management practices as implemented in plans for the area. Current management is described in section Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis"). Staff in the Lillooet Forest District provided information for the following management practices:

- Silviculture — reforestation activities required to establish free-growing* stands of acceptable tree species.
- Incremental silviculture —stand thinning. Use of improved seedlings is considered to be current practice in some management units in the province. However, at this time no improved seedlings are available for the Lillooet TSA
- Forest health and unsalvaged losses* — timber losses to fire, wind and pest (insect) damage. Estimated to be 26 080 cubic metres annually, on average.
- Utilization levels — minimum sizes of trees, and logs to be removed during harvesting.
- Minimum harvestable ages (MHA) — the time it takes for stands to grow to a merchantable condition. These were based on district priorities, age-volume yield tables and input from local forest industry representatives. Actual harvest age may be greater but not less than the minimum, and will depend on ages of other available stands, forest cover objectives* and overall timber harvest targets.

Free-growing
An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.
Unsalvaged losses
The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.

Forest cover objectives
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see Cutblock adjacency guidelines and Green-up).

- Cutblock adjacency* and green-up* — in the Lillooet TSA, approval of harvesting activities is contingent on previously harvested stands reaching a desired condition, or green-up (3 metres in height for integrated forest management area and 3 to 5 metres in height for visual quality management areas), before adjacent stands may be harvested. The purpose of the cutblock adjacency guidelines is to prevent timber harvesting from becoming overly concentrated in an area at any time. These guidelines were modelled by limiting the area within the integrated resource management (IRM)* zones that does not meet green-up conditions to a maximum of 33%.
- Ungulate* winter range (UWR) — To provide ungulates with acceptable winter cover and forage, requirements for a minimum percentage of mature forest cover were applied to critical winter ranges.
- Protection of environmentally sensitive areas (ESA)* where hazardous terrain, sensitive soils, recreation values, and avalanche hazards have been identified. To maintain ecological or other resource values, land has been wholly removed from the timber harvesting land base.
- Community watersheds — within designated watersheds a maximum of 20% of the forest area may be less than 6.6 metres in height at any given time. Community watersheds cover 19 191 hectares, or 6.5% of the timber harvesting land base.
- Maintenance of scenic values — maintaining important scenic values requires that visible evidence of harvesting be kept within limits in designated areas of the Lillooet TSA. The maximum proportion of the total forest in each scenic area* that may be covered by young stands that do not meet visual green-up requirements varies depending on the forest characteristics, the visual quality objectives (VQO)* and the visual absorption capability (VAC) for each area, ranging between 1% and 27.5%.

Ungulate
A hoofed-herbivore, such as deer.
Environmentally sensitive areas
Areas with significant non-timber values, fragile or unstable soils, or impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.
Scenic area
Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.
Visual quality objective (VQO)
Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.

Cutblock adjacency
The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Green-up
The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Integrated resource management (IRM)
The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.

- Landscape-level biodiversity* — to maintain biological diversity throughout a landscape unit*, the *Forest Practices Code* contains targets for the proportion of the area in each biogeoclimatic variant* that should be covered by stands with old-forest characteristics. Within the Lillooet TSA, old-forest is characterized by stands greater than 250 years old in natural disturbance types (NDT)* 1, 2, and 4 and 140 years in natural disturbance type 3. Since landscape units and biodiversity emphasis options (BEO) have not been established for each landscape unit, a weighted-average old-seral requirement was applied to draft landscape units.
- Harvest systems — clearcut and selection conifer harvesting are performed in the Lillooet TSA.

The data package for the Lillooet Timber Supply Area (TSA) was released in June 1999. As a result of public input, changes were required to the data package. The revised data package, which includes detailed descriptions of the management practices and the assumptions used to incorporate them into the analysis, is presented in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis" of this document.

Landscape-level biodiversity
The Landscape Unit Planning Guide provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.
Landscape unit
A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

Biogeoclimatic (BEC) variant
A subdivision of a biogeoclimatic zone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Natural disturbance type (NDT)
An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas with less stand-initiating disturbance have more older forests, and generally a greater abundance of species.

Figure 6 shows the proportions of the forested land base and the timber harvesting land base subject to management for scenic values, community watershed considerations, and ungulate winter range. Often several management objectives are applied to the same area; for example, all or part of a visual quality area may also be managed as a community watershed. In such a case, the area is required to meet all of the management objectives. The bar charts show the total area in each management emphasis area.

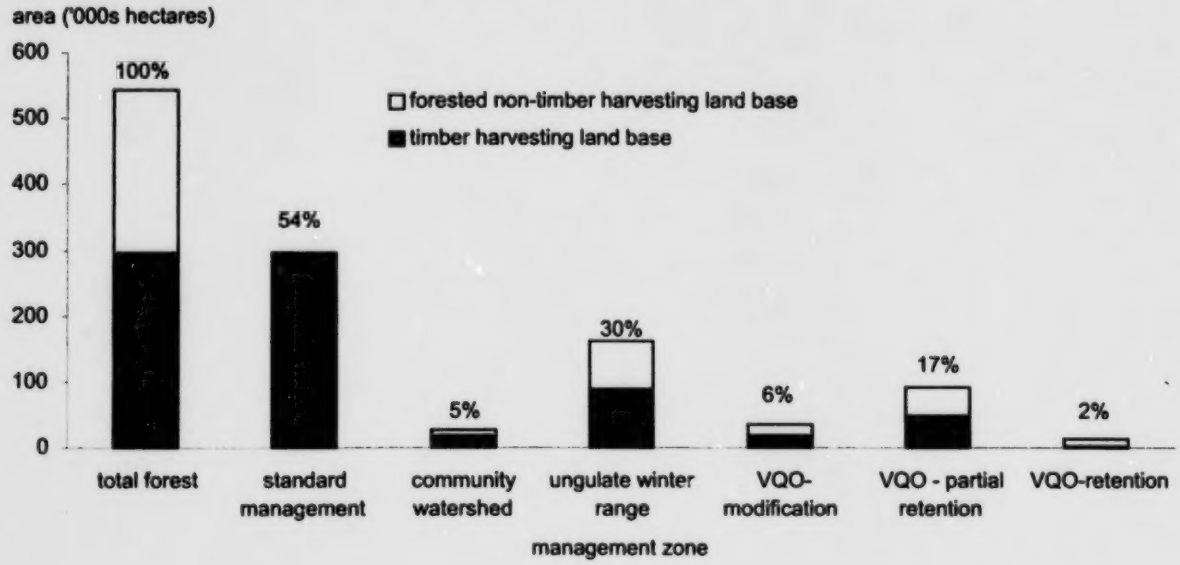


Figure 6. Forest management zones — Lillooet TSA forested land base, 2001.

Figure 7 shows the distribution of the land base by biogeoclimatic (BEC) variant. Also shown is the proportion of the total forest area in each BEC variant that is part of the timber harvesting land base. Table 3 provides a summary by BEC zone, indicating the composition of the total forest area and of the timber harvesting land base by BEC zone, and also showing the proportion of the total zone forest area that is within the timber harvesting land base. This latter number provides some indication of the likelihood that forest outside the timber harvesting land base will be sufficient to meet old-seral requirements. The table shows that for the zones that make up most of the forest area (ESSF, IDF and MS), 53%, 37% and 36% respectively of the total forest is outside the timber harvesting land base. While the percentages range among variants, overall the figures suggest that forest outside the timber harvesting land base is sufficient to meet old-seral requirements.

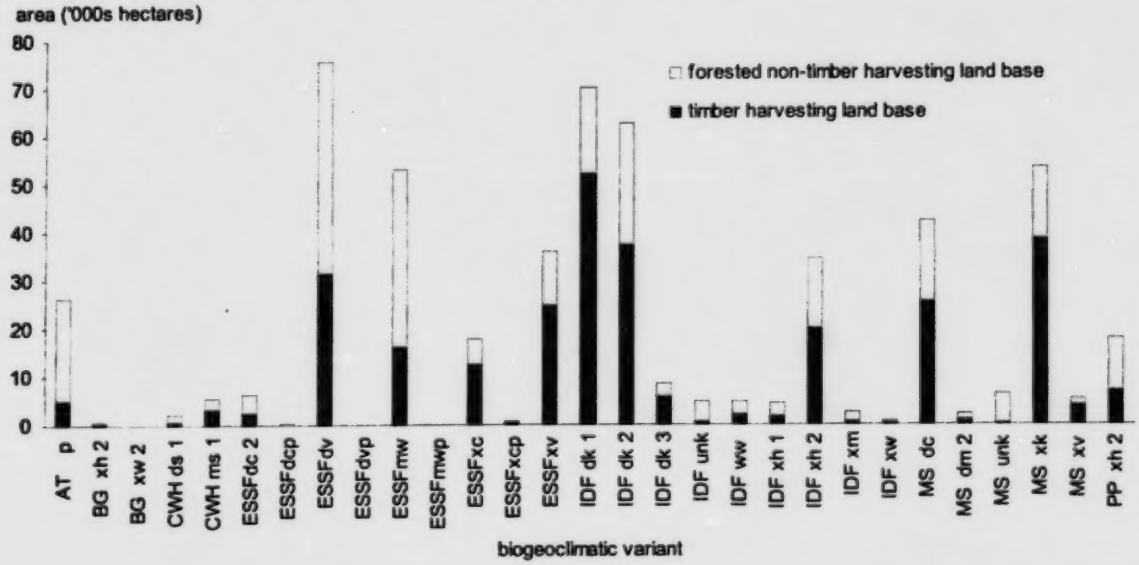


Figure 7. Area by biogeoclimatic classification — Lillooet TSA, 2001.

Table 3. Summary of biogeoclimatic zone areas — Lillooet TSA, 2001

Biogeoclimatic ecosystem classification (BEC) zone	Per cent (%) of total forest area in BEC zone	Per cent (%) of timber harvesting land base in BEC zone	Per cent (%) of total BEC zone area in timber harvesting land base
AT	4.8	1.8	19.9
BG	0.2	0.1	30.8
CWH	1.5	1.3	48.6
ESSF	34.9	30.0	46.7
IDF	35.4	41.0	63.0
MS	20.0	23.5	63.8
PP	3.3	2.3	38.6
Total	100.0	100.0	Not applicable

2.4 Changes since the 1995 Lillooet TSA analysis

The size and availability of the timber harvesting land base, management practices and modelling capabilities have changed since the last analysis for the Lillooet TSA. This section presents the major changes to the land base and forest management assumptions since the last analysis.

- In the last analysis the productive forested area considered in the Lillooet timber supply analysis was 529 152 hectares. For this analysis, the area managed by the Forest Service has decreased to 505 933 hectares, due primarily to the creation of the Stein Valley Nlaka'pamux Heritage Park in 1995. However, the area of productive forest included in the timber supply analysis has increased to about 545 000 hectares, mostly due to the inclusion of parks that can contribute to biodiversity considerations.
- The timber harvesting land base has changed since the last analysis. In the previous analysis the initial timber harvesting land base was 278 178 hectares. It is now 296 311 hectares, an increase of 6%. Creation of the Stein Valley Nlaka'pamux Heritage Park removed approximately 10 000 hectares of timber harvesting land base. However, use of terrain hazard assessments to replace environmentally sensitive area classifications for soils, as well as explicitly modelling the contribution of Pulpwood Agreement 16 has increased the timber harvesting land base significantly.
- Implementation of the *Forest Practices Code* has increased land base reductions for riparian reserves and volume reductions for wildlife tree patches (WTPs). Requirements to maintain or recruit suitable areas of old forest for landscape-level biodiversity also limit the availability of timber on the timber harvesting land base.
- The use of a computer-based geographic information system (GIS) in this analysis has allowed for application of management requirements at a finer level than was achievable in the last analysis.
- Riparian buffers are now applied on an area-specific basis rather than as general percentage area exclusions applied against all stands.

- Since the previous analysis, the area subject to visual quality objectives (VQO) has increased from 3% of the timber harvesting land base to 24%, due to availability of digital data. One of twelve distinct forest cover requirements* limiting visual disturbance is now applied to individual visual management polygons. In the previous analysis, a single average forest cover requirement was applied to a single zone that included all visual management areas in the timber supply areas.
- A 1997 inventory audit for the Lillooet TSA highlighted the possibility that existing stand volumes were being underestimated. Further study has shown this not to be the case on the timber harvesting land base.

In summary, the timber harvesting land base has increased by 6% and some modelling assumptions have changed since the last analysis. Given the extent of these changes, direct comparisons between this and the previous analysis cannot be made. Each analysis needs to be evaluated in the context of the management regime and related data inputs and assumptions that applied at the time. As noted in the introductory section, there is uncertainty surrounding information used in analyses, and forest management objectives change over time, which is why the *Forest Act* requires the Chief Forester to review the timber supply and AAC for each TSA periodically.

Any changes to the land base or management assumptions that occur or become effective after the completion of this timber supply analysis will be presented to the Chief Forester for consideration during the AAC determination, if possible.

Forest cover requirements
Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see Cutblock adjacency guidelines and Green-up).

3 Timber Supply Analysis Method

The purpose of this analysis is to examine both the short- and long-term timber harvesting opportunities in the Lillooet TSA, in light of current forest management practices. A timber supply computer simulation model developed by the B.C. Forest Service (FSSIM version 3.0) was used to aid in the assessment. A timber supply model, as distinct from a growth and yield model, assists the timber supply analyst in determining how a whole forest (collection of stands) could be managed to obtain a harvest forecast* (supply of timber over time). The simulation model uses information about the timber harvesting land base, timber volumes and the management regime to represent how trees grow and are harvested over a long period of time. Generally, only the results for the first 250 years are shown graphically in this report because the harvest level remains constant after that time.

Similar to other models, the B.C. Forest Service model assumes that trees grow according to provided yield projections and are harvested according to either a volume target or a specified objective set by the analyst. The Forest Service model also allows the use of forest cover guidelines that specify the desired age composition of the forest. These guidelines can be used to examine the effects of green-up and old-forest prescriptions. For example, guidelines might specify that no more than some maximum percentage of the forest can be younger than a specified green-up age or that some minimum percentage of the forest must be in older age classes to provide wildlife habitat. The B.C. Forest Service simulation model facilitates examination of the effects of such guidelines on timber supply.

This type of analysis is used to determine the timber supply implication of a particular management regime. The results of the analysis are especially important in determining allowable cuts that will not restrict options of future resource managers, and that will assist local B.C. Forest Service staff to administer their programs according to relevant guidelines and principles. However, the results of the analysis are not meant to be taken as recommendations of any particular AAC.

The main results of the analysis are forecasts of potential timber harvests and timber inventory changes (ages and volumes) over time. Although this information gives field staff only very limited guidance in the design of operational activities such as harvesting block location and silviculture planning, it does help ensure that the timber harvest level supports sustainable forest management in the field.

Harvest forecast
The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.

4 Results

This section presents results of the timber supply analysis for the Lillooet TSA. The base case harvest forecast uses the most recent assessments of current forest management, the land available for timber harvesting, and timber yields as described in Section 2, "Information Preparation for the Timber Supply Analysis." The impacts of uncertainty in the inputs to the analysis will be discussed in Section 5, "Timber Supply Sensitivity Analyses." The base case provides only a part of the timber supply picture for the Lillooet TSA, and should not be viewed in isolation of the sensitivity analysis*.

Section 2.4, "Changes since the 1995 Lillooet TSA analysis," provides an overview of the major changes to the land base and management assumptions since the last analysis. As noted in that section, any comparison between this and the last analysis should be made with recognition of the extent and nature of those changes. Each analysis should be evaluated in the context of the management regime and related data inputs and assumptions that applied at the time. Finally, one of the major reasons the Chief Forester is required under the *Forest Act* to periodically review the timber supply and AAC is to account for changes in management, information and knowledge.

4.1 Base case harvest forecast

The base case harvest forecast for the Lillooet TSA represents current management as described in the various sections of Appendix A of this report.

The base case does not include any interpretations or speculations on the outcome of the ongoing *Lillooet Land and Resource Management Plan** process. This process may recommend additional protected areas as well as develop management guidelines that differ from those found in Appendix A.

Figure 8 shows the base case harvest forecast for the Lillooet TSA. The initial harvest level is 661 600 cubic metres per year, which consists of the current AAC of 643 500 cubic metres per year, less 6900 cubic metres per that has been allotted to new woodlot licences, and the potential harvest of 25 000 cubic metres per year, currently allocated to Pulpwood Agreement (PA) 16 from within the TSA.

Sensitivity analysis
A process that examines how uncertainty in data and management assumptions affect timber supply.

Land and Resource Management Plan (LRMP)
A strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision making, and resource sustainability.

4 Results

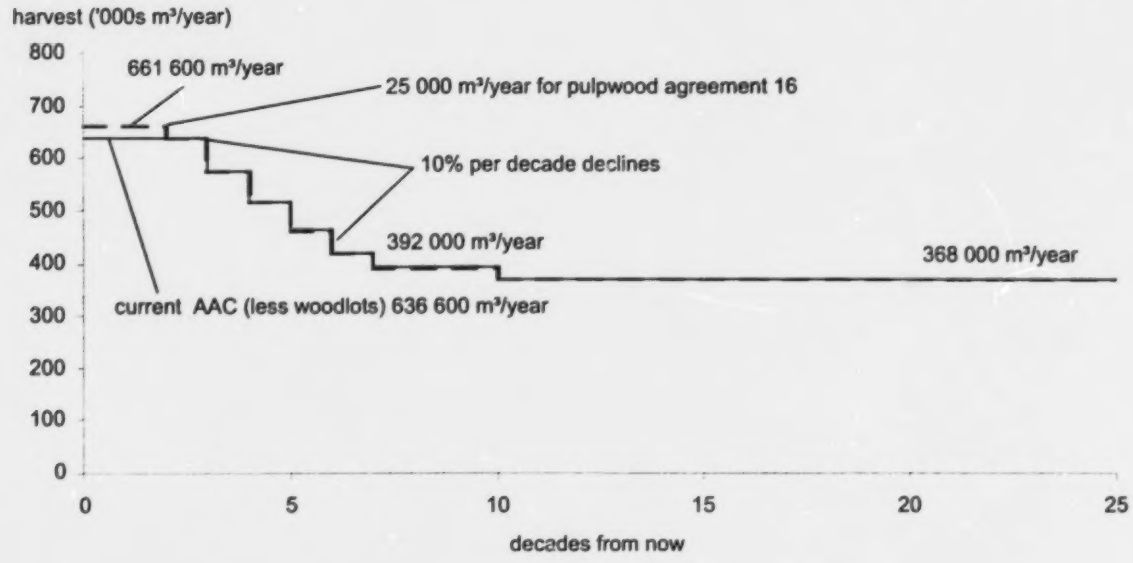


Figure 8. Base case harvest forecast for the Lillooet TSA, 2001.

Within the Lillooet TSA, specific harvesting attributable to PA 16 has yet to occur. Approximately 15 years remain until expiry of PA 16, and it is fully expected that given the current distribution of harvest across the four TSAs (Williams Lake, 100 Mile House, Kamloops and Lillooet) that contribute to the PA, there will soon be harvest activity in the Lillooet TSA. As there is a reasonable expectation that PA 16 will be active within the Lillooet TSA, its contribution is included in the base case.

An annual harvest level of 636 600 cubic metres could be maintained for thirty years before declining by 10% per decade to the long-term harvest level* of 368 000 cubic metres per year. The long-term level is 44% below the total initial harvest of 661 600 cubic metres per year, and 42% below the current level. Timber supply attributable to PA 16 is maintained at 25 000 cubic metres per year for the first 20 years of the forecast, which is the approximate time frame until the PA expires.

Unsalvaged losses due to natural forces such as insects, wind and fire are estimated to be 26 100 cubic metres per year for the entire 250-year horizon and have been subtracted from all harvest forecasts shown in this report.

Long-term harvest level
A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.

4 Results

The base case harvest forecast for the Lillooet TSA can be thought of as three integrated forecasts, the short-, medium-, and, long-term. The short-term harvest forecast is determined by the amount of currently existing timber growing stock*. Figure 9 shows a projection of timber inventory volumes over time corresponding to the base case harvest forecast. Total growing stock on the timber harvesting land base declines over the next 11 decades from 40 million cubic metres as the oldest of the existing mature stands are harvested and replaced by younger second-growth. Over the long term, the average total growing stock for the base case is 19.5 million cubic metres. Merchantable growing stock is defined as that volume of timber which is of harvestable age and is not required to satisfy other resource requirements, as defined in Appendix A. The average merchantable growing stock over the long term is 12 million cubic metres.

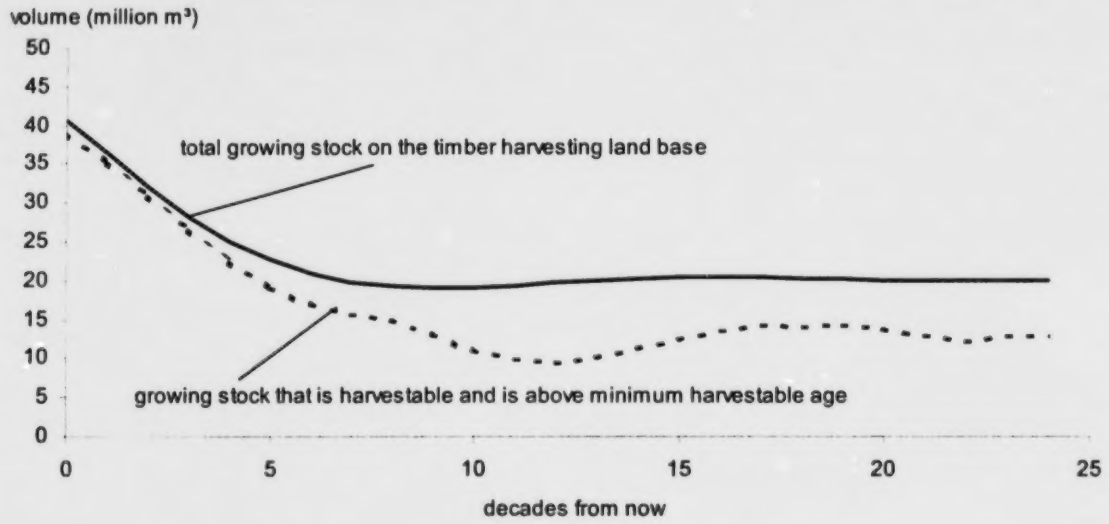


Figure 9. Total and merchantable growing stocks — Lillooet TSA, 2001.

The base case long-term harvest level of 368 000 cubic metres per year is the harvest rate that can be achieved while maintaining the total timber growing stock on the timber harvesting land base at an even level, on average, over the long term. An even-growing stock indicates that harvesting can continue at the corresponding harvest level in perpetuity. A continually increasing growing stock would indicate that the timber is being harvested below the productive capability of the land. A continually declining growing stock would signify that the timber is being harvested above the productive capability of the land.

Growing stock
The volume estimate for all standing timber at a particular time.

4 Results

The second component of the harvest forecast, the medium term, includes the transition of harvesting from existing older stands to managed future stands. Figure 10 shows the transition of harvesting from existing to managed stands, and the amount that each makes up in the base case forecast*. Also shown is the contribution of stands that currently meet the definition of Pulpwood Agreement 16. For the first eight decades the harvest depends fully on existing stands, and then during decades 9 through 11 the harvest becomes increasingly dependent on managed stands. In decade nine, harvests are projected to come predominantly from regenerated, managed stands. At this time the forecast approaches the long-term harvest level.

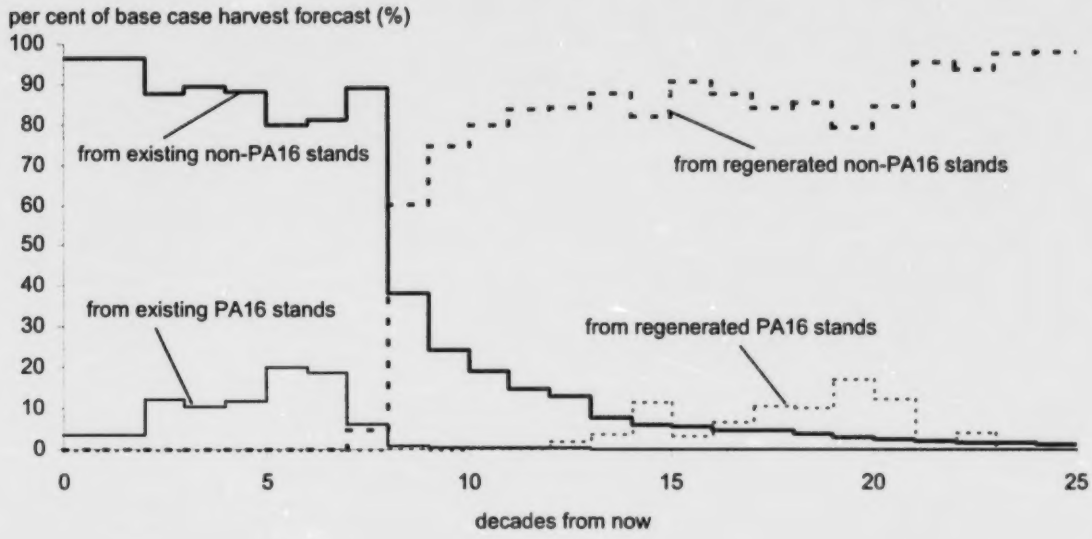


Figure 10. Harvest contribution from the existing and managed stands — Lillooet TSA, 2001.

The average growth rate projected from regenerated stands over the long term is about 1.39 cubic metres per hectare per year (the total timber supply, including non-recoverable losses (NRL), divided by the future timber harvesting land base). As noted in Appendix A, productivity estimates vary significant within the Lillooet TSA. If all stands were harvested at the age of maximum productivity, an annual harvest rate of approximately 450 000 cubic metres could be achieved in the long term. However, the long-term harvest level is below this theoretical maximum productive capacity of the timber harvesting land base. The maximum is not achievable since all stands cannot be harvested at the time of maximum productivity due to other management considerations on the land base and the objective of maintaining a consistent harvest flow over time.

Base case forecast
The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.

4.2 Area, average volume and average age harvested

Figure 11 shows the annual area harvested over the next 250 years (these areas have not been adjusted to account for the volumes deducted annually for non-recoverable losses) by both clearcut (even-aged) and selection (uneven-aged) harvest systems.

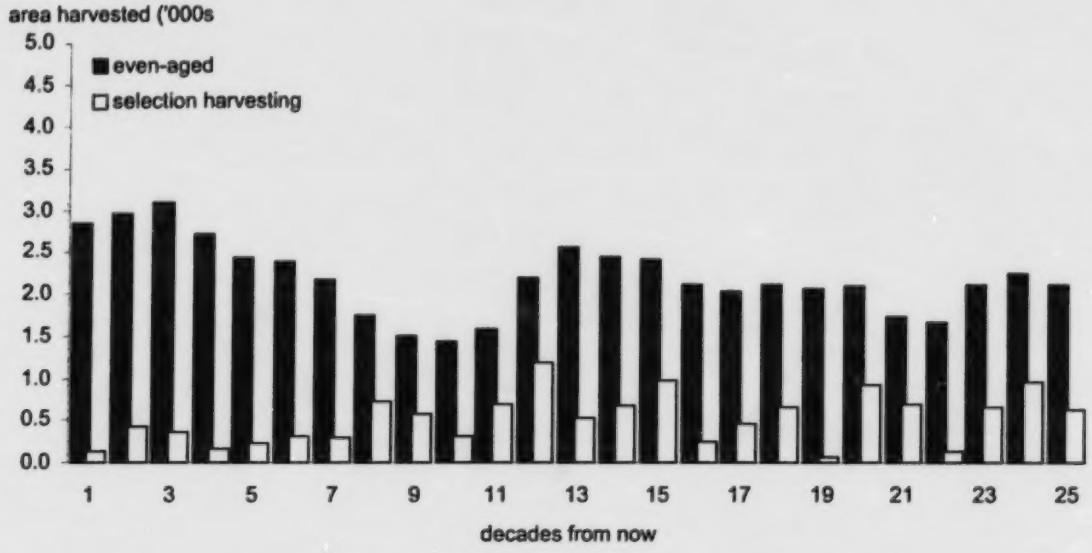


Figure 11. Average area harvested over time — Lillooet TSA base case, 2001.

Average area harvested begins to decline after the first three decades, corresponding to the declines per decade in the base case harvest forecast, to a low of 1760 hectares per decade (1440 hectares even-aged and 320 hectares uneven-aged harvesting) 10 decades from now. The average area harvested over the long term is about 2700 hectares per year.

4 Results

Figure 12 tracks the change in the area-weighted harvest age resulting from the base case forecast. Initially the harvest comes from the oldest stands in the timber harvesting land base. During the first 100 years of the forecast, the average harvest age is about 170 years. From decade 10 onward, managed stands comprise more of the forecast harvest, and the average age of the harvested stands declines to approximately 120 years. Areas harvested by selection methods are not included in the average harvest age calculation as these stands are made up of many different ages of trees.

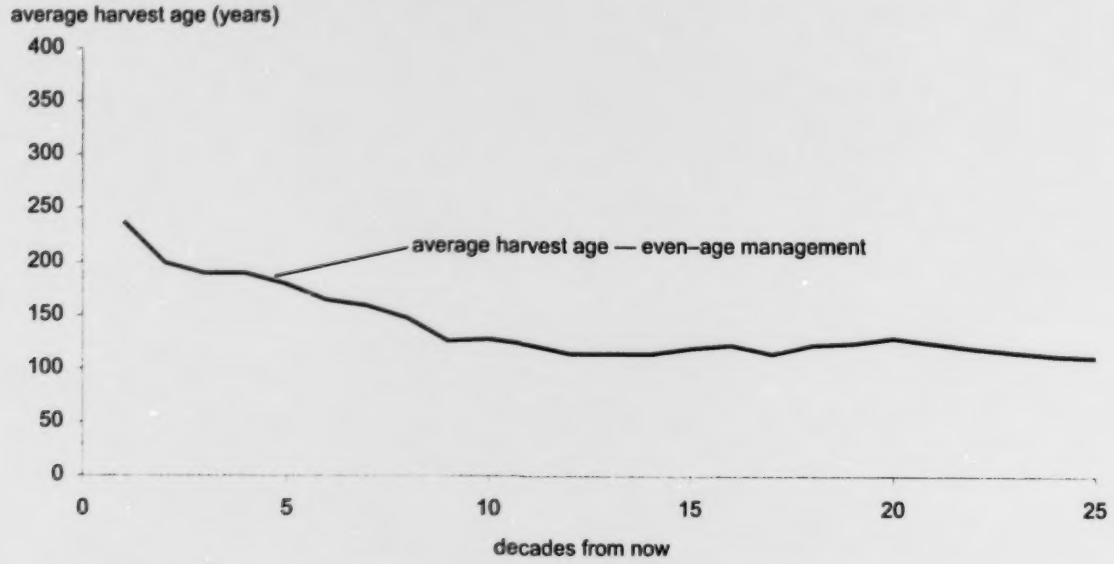


Figure 12. Average age of stands harvested over time — Lillooet TSA base case, 2001.

4 Results

Figure 13 shows the average timber volume harvested in the base case forecast. These average volumes were derived using the total harvested volume from either selection or even-aged harvested stands. No accounting was made for unsalvaged losses since it was not possible to adjust area harvested figures to account for the area corresponding to the losses. As shown in Figure 13, areas harvested with uneven-aged or selection systems remove a much lower volume per hectare on average. Selection systems remove lower amounts of volume, but harvests occur at more frequent intervals. Refer to Appendix A for a description of the selection management* regime. The average harvested volume for even-aged stands slowly declines during the first seventy years from 240 cubic metres per hectare to 220 cubic metres per hectare. The jump in average volume harvested during decades 8 and 9 is due the first significant number of managed stands being harvested. These stands are typically on better sites and contain higher volumes than the managed stands harvested later in the planning horizon. The increase in average volume harvested during decades 20 and 21 results from these same higher productivity stands being harvested again. Over the long term, the average volume per hectare harvested is about 180 cubic metres.

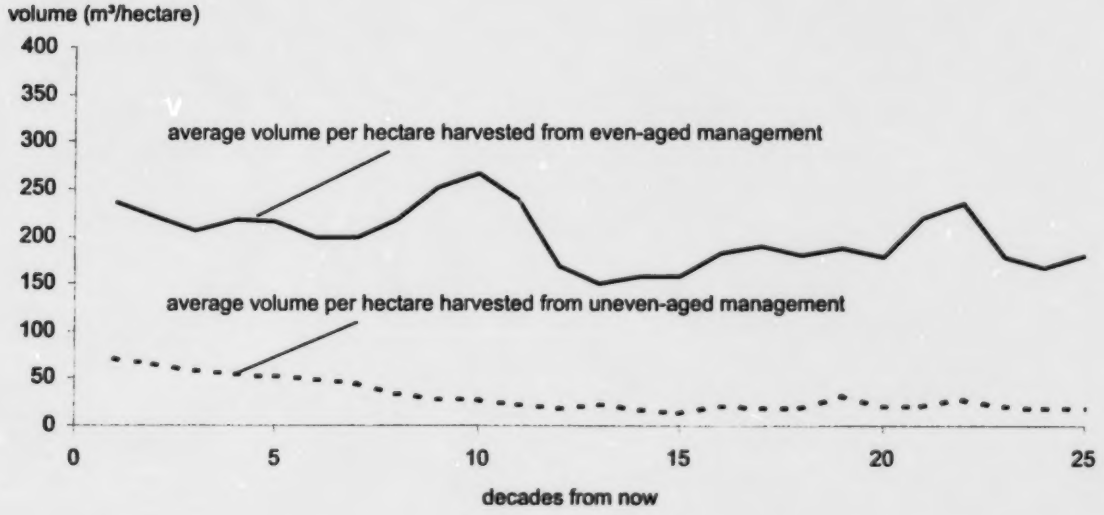


Figure 13. Average volume per hectare harvested over time — Lillooet TSA base case, 2001.

Selection management
A silvicultural system used to maintain or create areas containing a wide range of tree ages or sizes. The time interval between harvests in such areas is fairly short (usually less than 30 years), and during these harvests either single scattered trees or small groups of trees are removed from across the entire area.

4.3 Age class profile over time

The charts in Figure 14 show how the age composition of the Lillooet TSA productive forest land base changes over the next 250 years under the base case harvest forecast.

There are approximately 545 000 hectares of productive forest land base within the Lillooet TSA analysis area, of which 296 311 hectares makes up the initial timber harvesting land base. The current age class distribution shows about 75% of stands within the timber harvesting land base at or above minimum harvestable age. Five per cent of the timber harvesting land base is above 250 years of age and 35% is between 140 and 250 years of age.

The productive forest land base also contains stands that have been excluded from the timber harvesting land base. Outside of the timber harvesting land base, 62% of the stands are over 140 years old. Almost 8% of the Lillooet TSA is made up of stands greater than 250 years of age, 5% of which are from the non-timber harvesting land base.

One consequence of there being a large area (249 000 hectares) of stands outside the timber harvesting land base, is that a relatively small proportion of the timber harvesting land base needs to be reserved from harvest to meet old seral* landscape-biodiversity objectives until stands outside the timber harvesting land base age. In 200 years approximately 2900 hectares of the timber harvesting land base are forecast to be occupied by stands over 250 years of age. All other requirements have been met from outside the timber harvesting land base. Within the non-timber harvesting land base, 226 000 hectares of forest are forecast to be older than 250 years, as seen in Figure 14.

Old seral
Old seral refers to forests with appropriate old forest characteristics which provide for biodiversity. Ages vary depending on forest type and biogeoclimatic variant.

4 Results

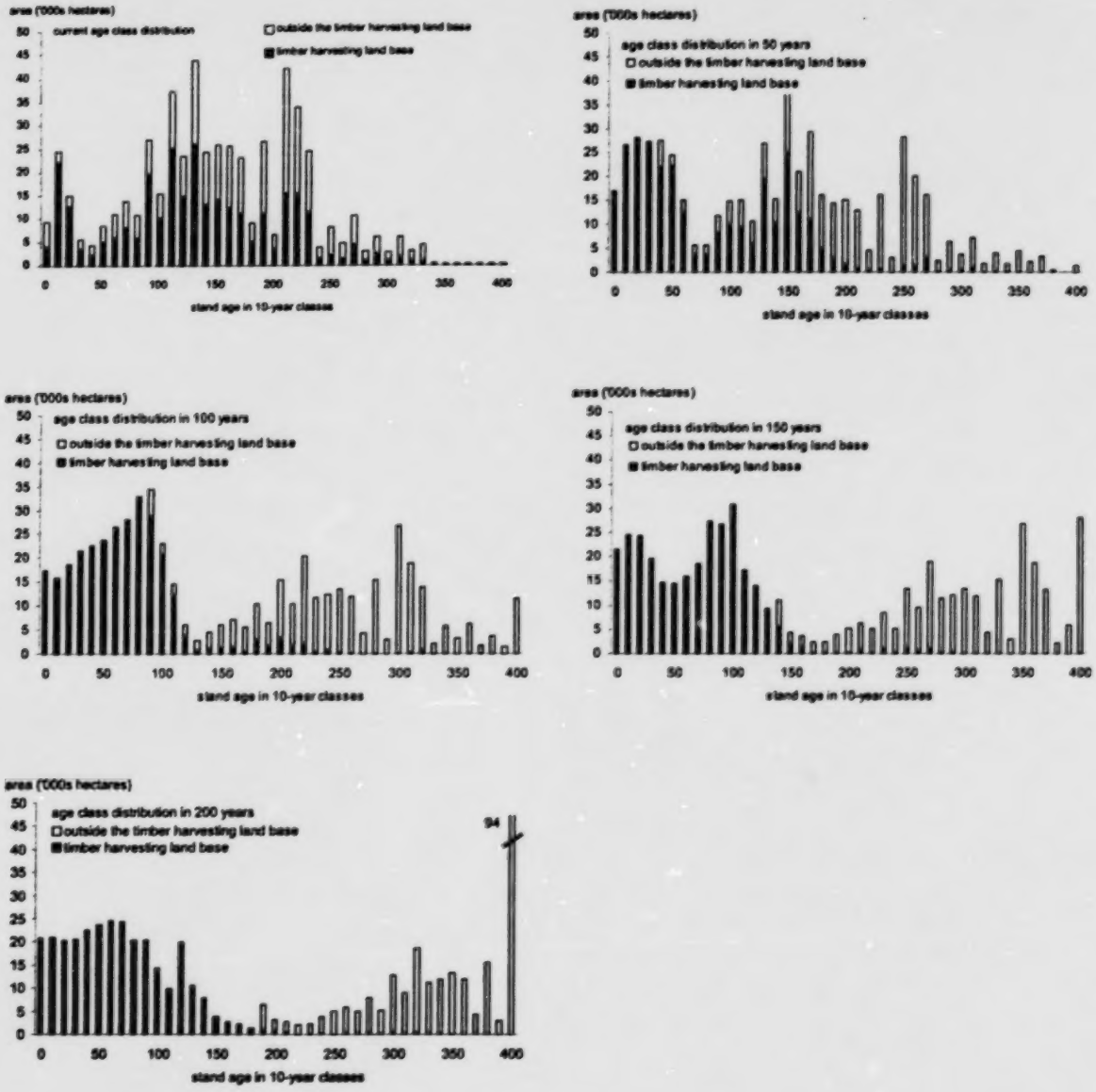

area ('000s hectares)
current age class distribution
outside the timber harvesting land base
timber harvesting land base
stand age in 10-year classes
age class distribution in 50 years
age class distribution in 100 years
age class distribution in 150 years
age class distribution in 200 years
94

Figure 14. Changes in age composition on the productive land base over time — Lillooet TSA base case, 2001.

5 Timber Supply Sensitivity Analyses

The best available information on forest inventories and management practices is used to analyse the timber supply implications of continuing with current management. However, forest management is complicated since it must account for diverse and changing human values, the dynamics of complex ecosystems, and fluctuating and uncertain economic factors. As well, forests grow quite slowly in terms of human time spans, so that decisions we make today have not only short-term but also long-term effects beyond the life spans of current decision makers. In such a context, we cannot be certain that all the data accurately reflect the current state of all values in the forest, how the forest will change, or how our management activities will affect the forest.

One important way to deal with this uncertainty is to revise plans and analyses frequently to ensure they incorporate up-to-date information and knowledge. Frequent planning and decision-making can help minimize any negative effects that may occur if decisions are based on inaccurate information. Frequent revision can also ensure that opportunities that become apparent from new information are not missed.

Another important way of dealing with uncertainty is to assess how values of interest, for example, timber supply, could change if the information used in the analysis is not accurate. Sensitivity analysis is one way of evaluating how uncertainty could affect analysis results, and ultimately decision-making. Sensitivity analysis can highlight that fairly small uncertainties about some variables could have large effects on timber supply projections, or conversely that fairly large inaccuracies in others could have negligible effects. Also, sensitivity analysis could show that some variables affect timber supply more in the short term than in the long term, while others have the opposite effect. Sensitivity analysis can highlight priorities for collecting information for future analyses, and show which variables, and associated uncertainties, have the most significance for decisions. It can clarify whether current best estimates provide a safe basis for decisions, or whether high uncertainty about important variables means more conservative decisions may be wiser.

In this section, results of several sensitivity analyses are discussed. The results based on current forest management assumptions (from Section 4, Figures 4.1 through 4.3) are referred to as the base case.

Unsalvaged losses to natural forces such as insects, fire, and wind are estimated to be 26 100 cubic metres per year for the entire 250-year horizon, and have been subtracted from all harvest forecasts shown in this report.

5.1 Alternate harvest flows over time

The base case harvest forecast shown in Figure 4.1 was developed subject to several assumptions. For example, the initial harvest level was predetermined by the current allowable annual cut. The harvest level shown for Pulpwood Agreement 16 was based on the current allotment in the Lillooet TSA, and the length of time remaining in the agreement.

Figure 15 compares two alternative forecasts with the base case. In both forecasts, the amount of harvest ascribed to Pulpwood Agreement 16 remains constant at 25 000 cubic metres per year for the first 20 years. All inputs related to land base, growth and yield and management remain constant in all forecasts in Figure 15.

Maximum non-declining even-flow (alternative 1)

- The non-declining even-flow harvest level of 404 000 cubic metres per year can be maintained for 400 years.
- This represents a 40% reduction in the short-term harvest level for the TSA.
- Long-term harvest level is about 9% higher than the base case.
- Transition of harvesting from existing to managed, regenerated stands begins to occur in approximately decade 13, as compared to decade 8 in the base case.

Higher initial level forecast (alternative 2)

- First-decade harvest is the maximum achievable while maintaining 10% per decade declines and without dropping below the long-term harvest level.
- Initial harvest level is 770 000 cubic metres per year, 16% above the base case initial harvest level.
- Starting level is limited only by the amount of growing stock that must be reserved until second-growth stands reach harvestable age.

5 Timber Supply Sensitivity Analyses

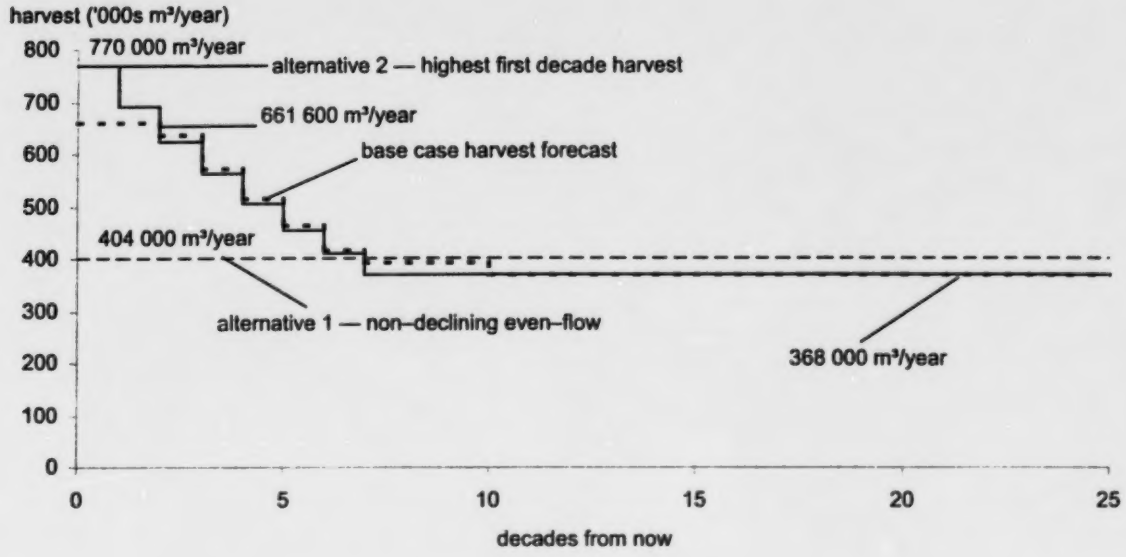


Figure 15. Alternative harvest forecasts — Lillooet TSA, 2001.

5.2 Uncertainty in the land base available for timber harvesting

Uncertainty in the estimated size of the timber harvesting land base is due to factors such as fluctuations in timber prices, changes in the definition of problem forest types (PFT), changes in harvesting and milling technology and land-use decisions.

The timber harvesting land base has changed significantly since the last timber supply analysis for the Lillooet TSA. While the land base was reduced somewhat for factors such as the Stein Valley Nlaka'pamux Heritage Park and riparian reserves, it has also increased significantly due to the explicit inclusion of Pulpwood Agreement 16 and the substitution of terrain class information, where it was available, for environmentally sensitive areas for soils.

Currently there is no indication that the timber harvesting land base has been over- or under-estimated. However, sensitivity analyses were performed to provide general information that might help evaluate the implications of any new information that becomes available before the AAC determination. The first analysis evaluates the outcome of decreasing the timber harvesting land base by 10%. The second scenario evaluates a 10% decrease of the non-timber timber harvesting land base. These results are discussed in subsection 5.2.1. A further analysis, discussed in subsection 5.2.2, examines the timber supply contribution of the PA 16 area.

5 Timber Supply Sensitivity Analyses

5.2.1 General land base uncertainty

Table 4 shows the base case and shifted land bases for the sensitivity analyses. Figure 16 shows the resulting harvest forecasts.

Table 4. Area of the base case and land base sensitivity analysis

Forecast	Timber harvesting land base (hectares)	Forest outside timber harvesting land base (hectares)	Total (hectares)
Base case	296 000	249 000	545 000
Reduce timber harvesting land base by 10%	266 000	279 000	545 000
Reduce the non-timber harvesting land base by 10%	321 000	224 000	545 000

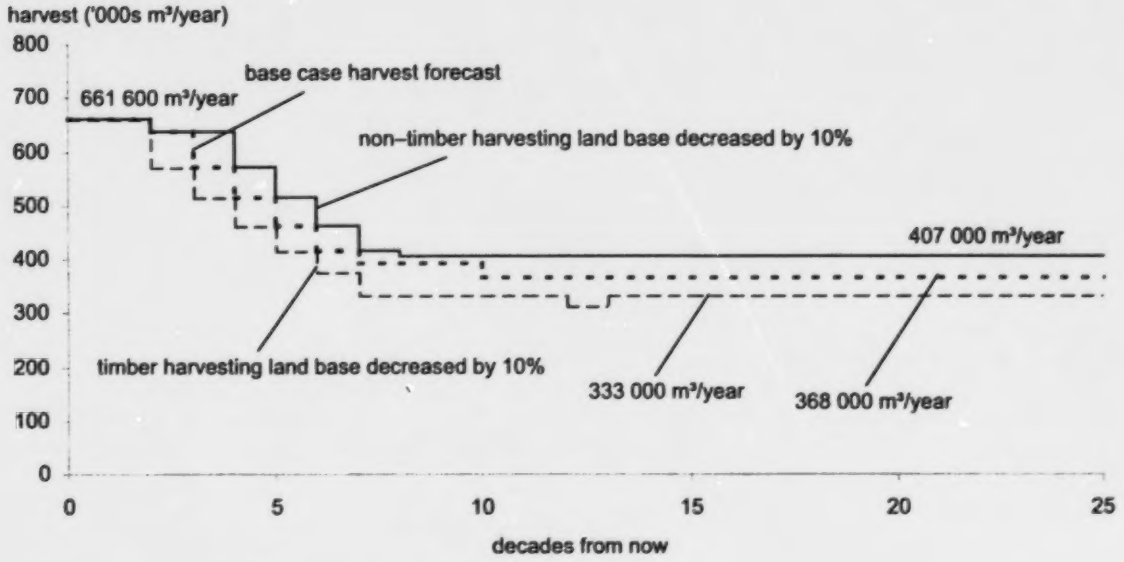


Figure 16. Land base sensitivity analysis — Lillooet TSA, 2001.

If timber harvesting land base is 10% smaller than in the base case

- Still sufficient area in older existing stands to support the base case initial harvest for two decades.
- After two decades harvest decreases by 10% per decade
- Long-term harvest level of 333 000 cubic metres per year, about 10% below the base case, reached in seven decades.

If non-timber harvesting land base is 10% smaller than in the base case

- Current harvest level can be maintained for an additional decade (four decades in total).
- Long-term harvest level approximately 10% higher than the base case long-term level, reached in decade 8.

5.2.2 Pulpwood area 16 contribution

The area associated with the explicit inclusion of Pulpwood Agreement 16 is approximately 42 500 hectares or 14% of the timber harvesting land base. This land base includes stands under 17 metres in height within a portion of the Lillooet TSA. The base case harvest forecast assumed the PA 16 land base would revert back to the regular timber harvesting land base in 20 years time.

Figure 17 displays two harvest projections that result if the area associated with PA 16 did not contribute to the timber harvesting land base after the first 20 years.

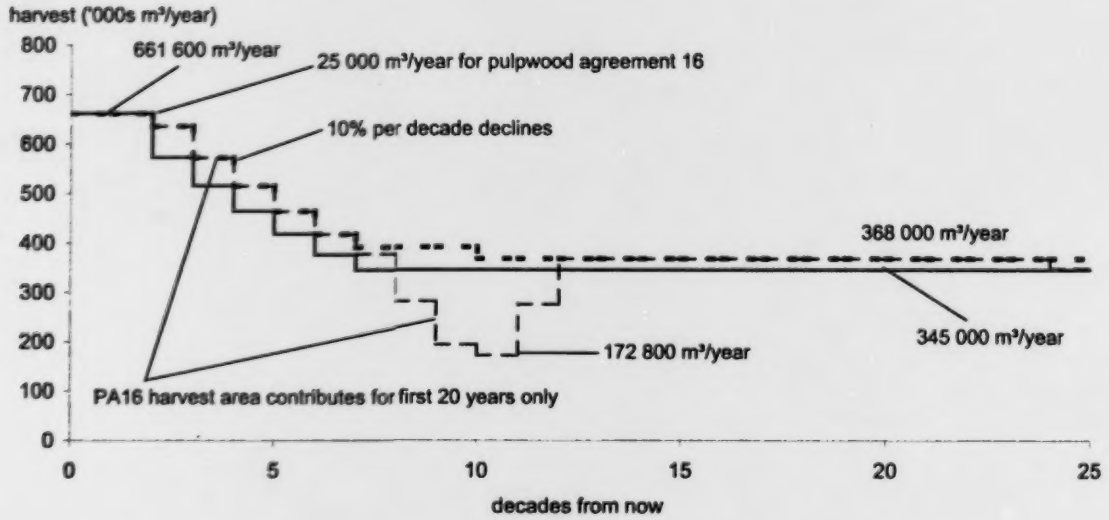


Figure 17. Pulpwood agreement 16 land base sensitivity analysis — Lillooet TSA, 2001.

With no PA 16 area after 20 years

- Initial harvest level can be maintained for only 20 years before beginning 10% per decade declines.
- Long-term harvest level 6% below the base case level; reached in decade 7.

If the PA 16 land base does not contribute to the timber harvesting land base after 20 years, yet harvests continued at base case levels, a severe shortage of supply would occur between decades eight and twelve (dashed line).

5.3 Uncertainty in the estimated existing stand yields

Timber volume estimates for existing unmanaged stands are subject to uncertainties in the forest inventory used to estimate timber volumes (i.e., estimated tree heights and stand ages), and the statistical process used to develop the equations for predicting forest growth and yield. Timber volumes are normally accurate when averaged over large areas, but may not reflect actual volumes within individual stands. Uncertainty may also arise in the estimates of the volume lost both to decay in older trees, and to waste and breakage during harvest, and of the utilization levels practiced during harvesting. In addition, stand-level biodiversity requirements for the Lillooet TSA were addressed in this analysis through the removal of volume from each stand as it was harvested. Uncertainty may arise around the exact estimates of volumes left behind for stand-level biodiversity.

Inventory audit

During the last several years, Resources Inventory Branch has performed audits of the standing volume of trees within TSAs and TFLs* across the province. These audits provide an indication of how confident we can be that the estimates of volume are close to the actual volumes in the management unit. For the Lillooet TSA, initial indications from the inventory audit were that standing volumes were being underestimated by approximately 18%. A more intensive study involving 128 additional samples was undertaken to determine the accuracy of the initial audit. Resources Inventory Branch also found that an update was needed in their computer program used to generate volumes. The corrected audit showed there to be a standing volume underestimate of 12% across the TSA. On the timber harvesting land base portion of the TSA, the results of the additional 128 samples showed there to be no difference between inventory- and ground-based estimates of standing volumes. However, indications were that actual volumes in the non-timber harvesting Crown forest land base were approximately 40% higher than estimated by the inventory. Since harvested volumes are only taken from the timber harvesting land base, no adjustment was made to the inventory file prior to the timber supply analysis.

Given the uncertainties in existing stand volumes, the impacts of decreasing and increasing existing unmanaged stand yields (yield curves created through VDYP) by 10% were assessed. Figure 18 displays the results.

Tree farm licence (TFL)
Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.

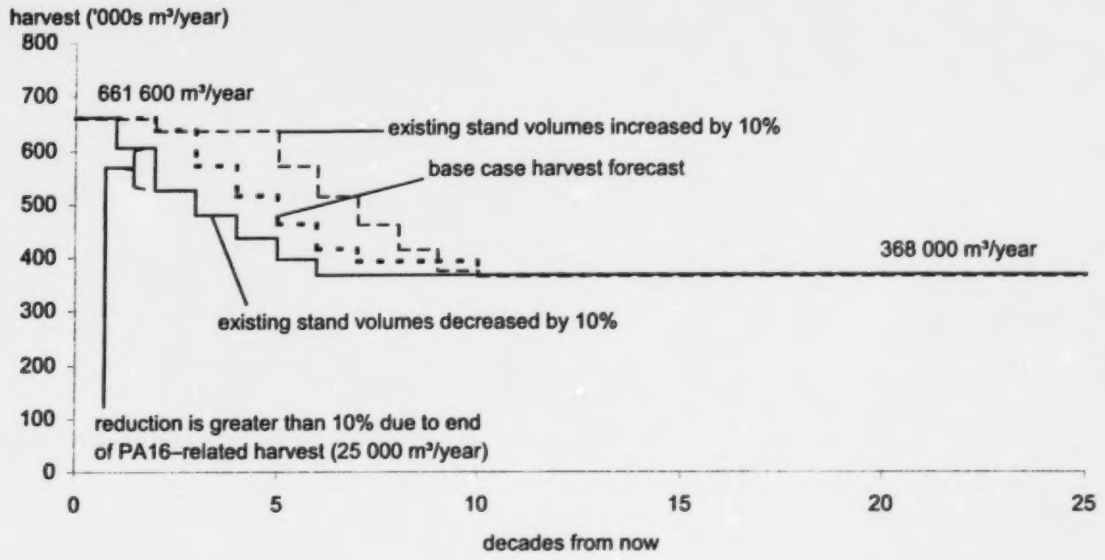


Figure 18. The effect on the harvest forecast of increasing and decreasing volume estimates for existing unmanaged stands by 10% — Lillooet TSA, 2001.

<u>If existing unmanaged stand volumes are 10% lower than in base case</u>

- The regular AAC of 636 600 cubic metres per year can be maintained for only one decade rather than three decades as in the base case.
- The harvest forecast declines by 9% per decade after decade three, reaching the long-term level four decades earlier than the base.
- The 25 000 cubic metres per year for PA 16 can still be maintained for two decades, (note significant decrease between decades two and three).

<u>If existing unmanaged stand volumes are 10% higher than in base case</u>

- A harvest level of 636 600 cubic metres per year can be maintained for five decades rather than the base case value of three decades.
- The harvest level for PA 16 is unchanged at 25 000 cubic metres per year for the first two decades.
- After five decades, the harvest forecast declines by 10% per decade.
- The long-term harvest level is reached at the same time as the base case.

In summary, much work has been done in the Lillooet TSA to determine whether the volumes from existing stands are accurate across the timber harvesting land base. Since the initial harvest level is approximately 45% higher than the long-term harvest level, changes in existing volumes could have a significant effect if the volumes were either over- or under-estimated. Further sampling is occurring in the Lillooet TSA and as those results become available they will be incorporated into future decisions.

5.4 Uncertainty in the estimated managed stand yields

Uncertainty in volume estimates for managed stands exists for the same reasons listed for estimated existing stand yields (inaccuracies in the forest inventory and the growth and yield models), but also because of the limited experience and data that is available for regenerated managed stands in B.C. In this section, the timber supply effects of uncertainty associated with predicting volumes in regenerated stands is examined.

Figure 19 shows the harvest forecasts that result when regenerated stand volumes are increased and decreased by 10%.

Regenerated stand yields decreased by 10%

- Harvest level decreases by 16% at beginning in decade 9 to a new long-term harvest level of 328 000 cubic metres per year in decade 10.
- New long-term level is 11 % below the base case long-term level.

When regenerated stand yields are increased by 10%

- Long-term harvest level increased to 411 000 cubic metres per year, 11.5% greater than the base case, beginning in decade 10.

Changes to regenerated stand yields have no effect on the short-term harvest forecast for the Lillooet TSA. Regenerated stands are not eligible for harvest until they have reached their minimum harvestable ages, which average between 80 and 120 years. While some young existing managed stands will achieve their minimum harvestable ages beginning in a few decades, the timber inventory in the TSA is dominated by older existing stands. The harvest is not projected to be dominated by regenerated stands until about 90 years from now (refer to Figure 10)

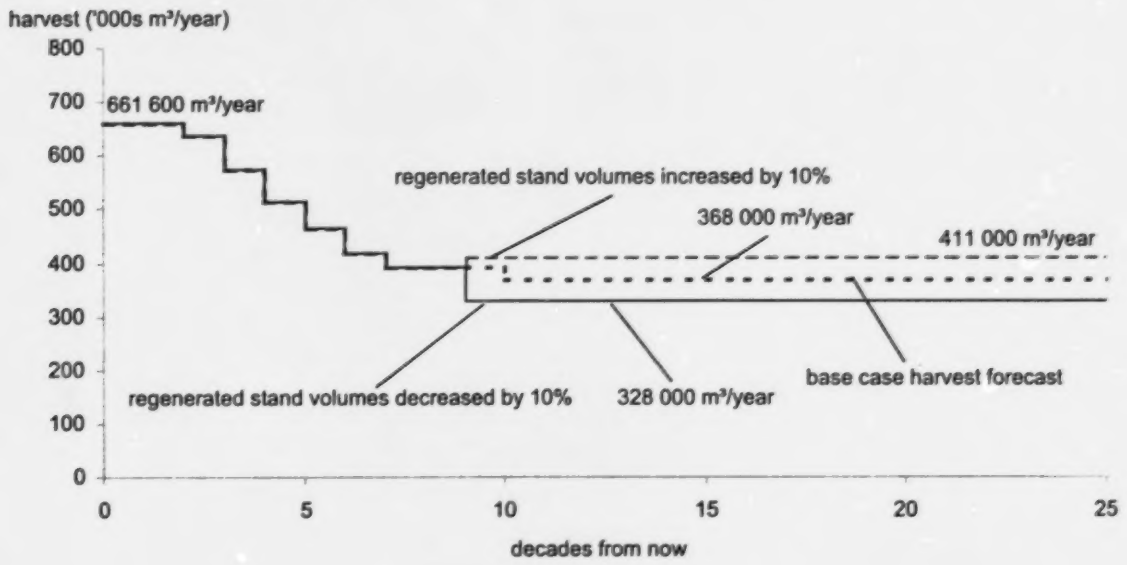


Figure 19. The effect on the harvest forecast of increasing and decreasing volume estimates for managed stands by 10%— Lillooet TSA, 2001.

5.5 Uncertainty about management requirements in visually sensitive areas

In the Lillooet TSA, areas determined to be visually sensitive to timber harvesting occupy approximately 24% of the timber harvesting land base. Where visual quality objectives apply, limits are placed on the percentage of the area where harvesting-related disturbance may be visible. When newly established forest reaches a specified height, the disturbance is no longer visible. Uncertainties are associated with both the allowable disturbance percentages and achievement of visually effective green-up.

Percentage limits on visible disturbance

The level of harvest from visually sensitive areas is a function of the visual absorption capacity, the visual quality rating, and the current visual condition of each area. Uncertainty about forest cover and green-up objectives for visual quality may arise from inventory and classification of land into visual absorption capacity classes, from estimates of how well different disturbance limits may meet visual objectives, and from estimates of how non-harvestable forest may contribute to visual quality. The constraint levels are currently under discussion at the LRMP table and may be changed following completion of the LRMP.

In the base case, the mid-point of the applicable range of allowable visible disturbance was applied to each visual management polygon. Sensitivity analyses were performed to assess the impacts of relaxing and increasing forest cover constraints for visual quality. Figure 20 shows the results.

Relaxing the forest cover constraints to the maximum level

- Harvest forecast same as base case for first three decades.
- Decline to the long-term level is slower than base case (8% per decade rather than 10%).
- Long-term harvest level is 4% higher than the base case.

Decreasing the allowable disturbance in visual areas to the minimum of the range

- Harvest forecast same as base case for first three decades.
- 11% decline per decade would be required.
- Long-term harvest level 2% lower, and reached three decades earlier than the base case.

5 Timber Supply Sensitivity Analyses

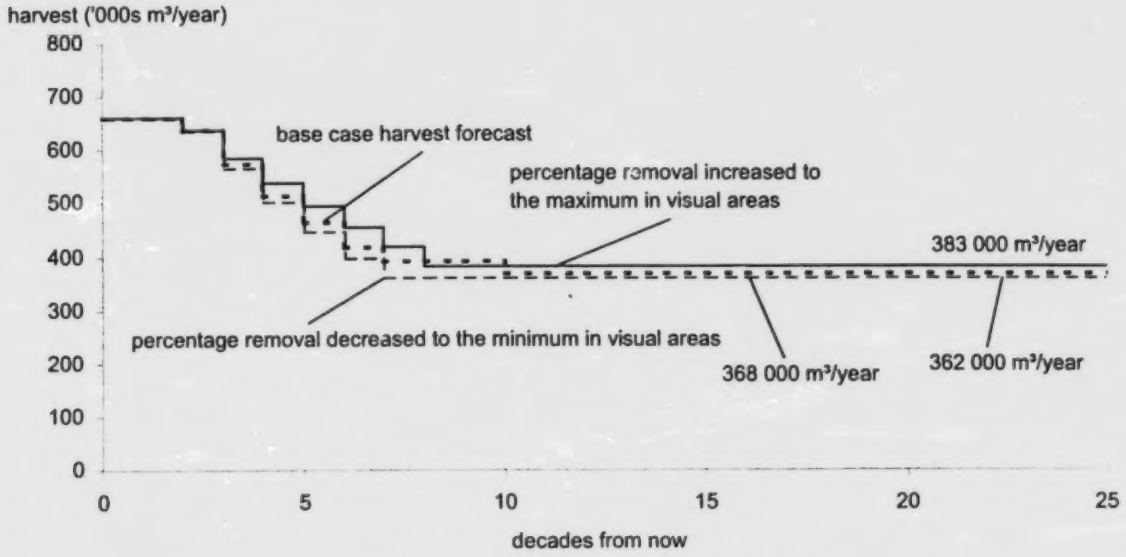


Figure 20. Effects on timber supply of increasing and decreasing forest cover constraints for visually sensitive areas to the maximum and minimum of the range — Lillooet TSA, 2001.

Visually effective green-up

Within visually sensitive areas, the regenerated stand in previously harvested cutblocks must reach a specified height before adjacent areas may be harvested. The green-up period required to reach the specified height varies from 19 to 28 years within the Lillooet TSA. Both uncertainty around estimates of site index, and different silvicultural treatments* may result in trees reaching the appropriate visually effective green-up height sooner or later than assumed. As well, the LRMP table may alter these constraint levels. Figure 21 shows the results of increasing and decreasing the visually effective green-up ages by five years.

Increasing and decreasing visually effective green-up ages

- No effect on the length of time the initial harvest level can be maintained by either increases or decreases to visually effective green-up ages.
- Long-term harvest level changes by only 1-2%.

Silvicultural treatments
Activities that ensure the regeneration of young forests on harvested areas, enhance tree growth or improve wood quality in selected stands. Activities include: site rehabilitation and preparation, planting, spacing, fertilization and pruning.

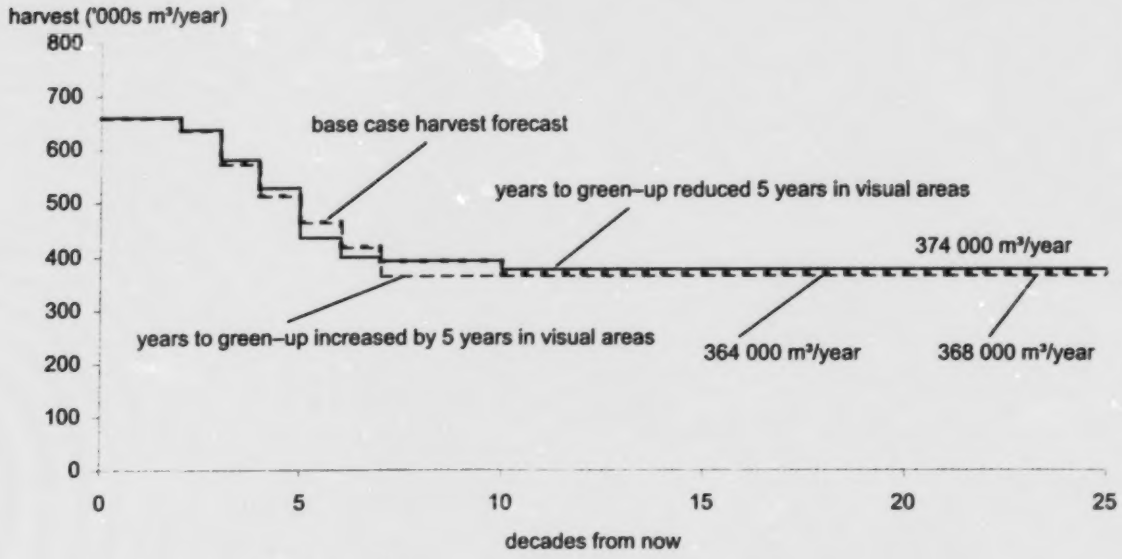


Figure 21. The effect on the harvest forecast of increasing and decreasing green-up constraints for visually sensitive areas by 5 years — Lillooet TSA, 2001.

5.6 Uncertainty in minimum harvestable ages

Minimum harvestable ages are an estimate of the time needed for stands to reach a merchantable condition. They affect the time over which existing stands must be metered-out while regenerated stands grow to merchantability. The time at which stands will become merchantable is not known with precision because of uncertainty about the growth of regenerated stands, and an inability to foresee future conditions that will determine merchantability.

For this analysis, minimum harvestable ages for existing stands were estimated to be either 80 or 100 years, and are detailed by leading species in Appendix A, "Description of Data Inputs and Assumptions for the Timber Supply Analysis." Approximately 76% of the existing timber harvesting land base in the Lillooet TSA is currently at or above the minimum harvestable age applicable to the stand. Managed, or regenerated, stands have different minimum harvestable ages, determined based on achieving approximately 90% of the culmination of mean annual increment (MAI)*, which are also detailed in Appendix A. The minimum harvestable ages for managed stands range from 70 years on good site areas to 240 years on lowest site balsam stands. Minimum harvestable ages are meant to approximate the timing of merchantability and are not legal or policy requirements.

Mean annual increment (MAI)
Stand volume divided by stand age. The age at which average stand growth, or MAI, assumes its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.

Figure 22 shows the impact of increasing and decreasing minimum harvest ages by 10 years for each leading species.

Ten year decrease in minimum harvestable ages

- One additional decade of harvest at the initial level of 636 600 cubic metres per year.
- Decline rate of 11% per decade.
- The ability to hold the initial harvest level a decade longer (managed stands become available for harvest earlier).
- Long-term harvest level about 3% lower than the base case (stands are harvested further away from their biological maximum mean annual increment).

Ten year increase in the minimum harvestable ages

- Initial harvest level held for only two decades (existing forest must support harvests for longer period before managed stands become available).
- Long-term harvest level about 4% higher than the base case (managed stands are harvested closer to the their maximum mean annual increment age).

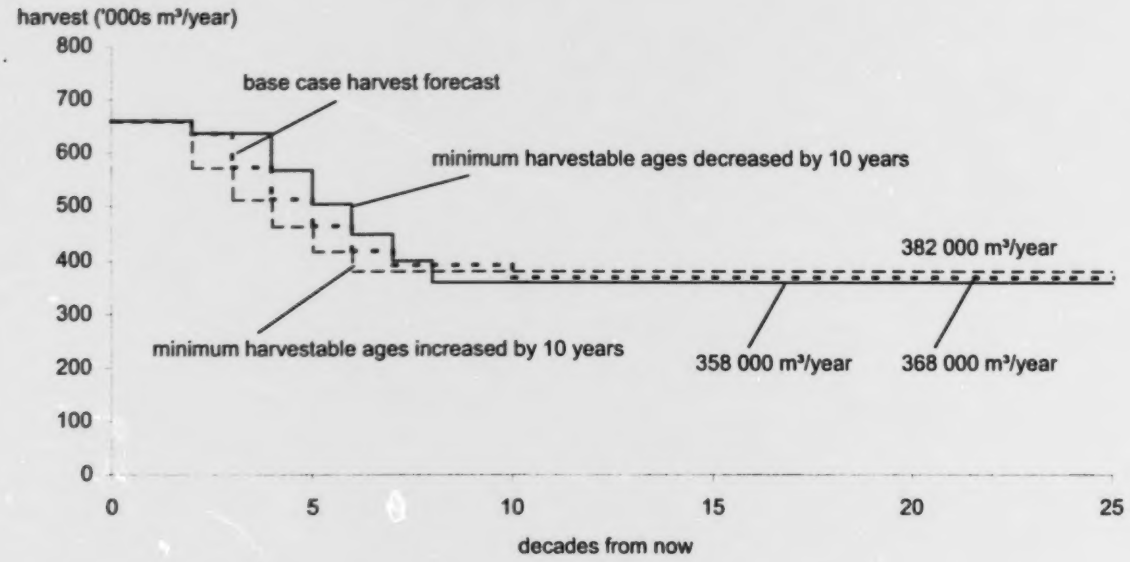


Figure 22. The effect on the harvest forecast of increasing and decreasing minimum harvestable ages by 10 years — Lillooet TSA, 2001.

5.7 Uncertainty in green-up requirements

Within the Lillooet TSA base case it was assumed that no more than 33% of the timber harvesting land base within each landscape unit (LU), biogeoclimatic zone variant (becvar) combination could be less than 3 metres in height (20 years). The 33% limit approximates a 3-pass harvest system. Both the percentage limitation and the age at which green-up is assumed to occur are sources of uncertainty.

Percentage allowed below green-up

Figure 23 shows the effects of allowing no more than 25% (4-pass) and 20% (5-pass) of the area to be below 3 metres in height.

Maximum of 20% below green-up (5-pass)

- Significant short-term reduction in timber supply: first decade harvest drops to 617 000 cubic metres per year from the base case level of 661 600 cubic metres per year.
- Long-term harvest level increases by 12 000 cubic metres per year relative to the base case due to a shift of the short- and mid-term timber supply into the longer term.

Maximum of 25% below green-up (4-pass)

- Only small deviations from the base case harvest forecast (third and thirteenth decades).

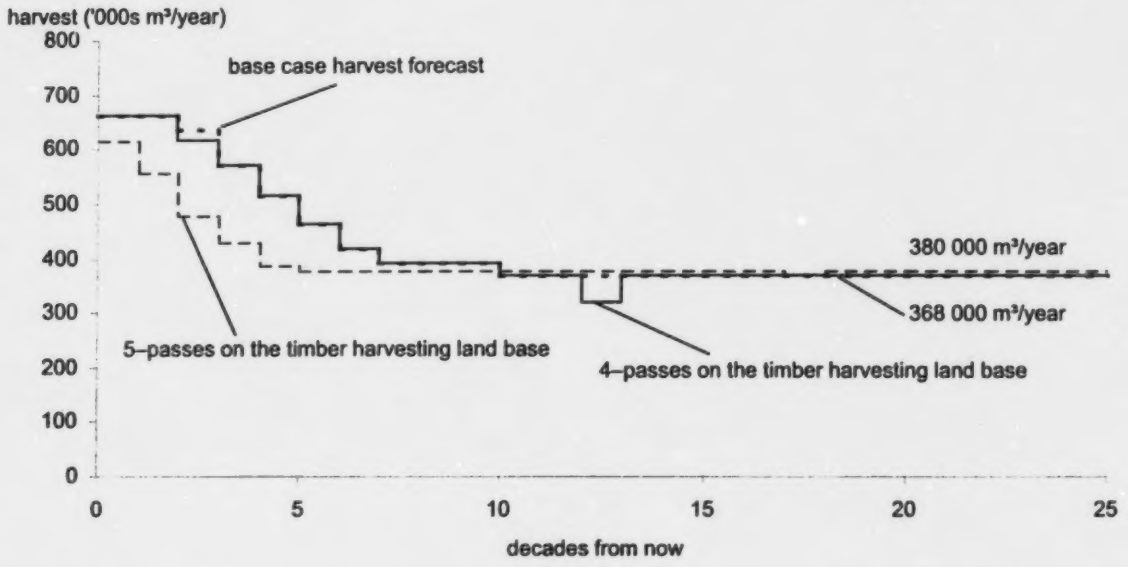


Figure 23. The effect on the harvest forecast of decreasing the allowable area below green-up — Lillooet TSA, 2001.

Green-up age

- Achieving a green-up height of 3 metres requires approximately 20 years on average in the Lillooet TSA (based on current site productivity information).
- No difference in short-term timber supply, and small differences in medium- and long-term harvest levels due to 5-year changes in green-up ages (Figure 24).

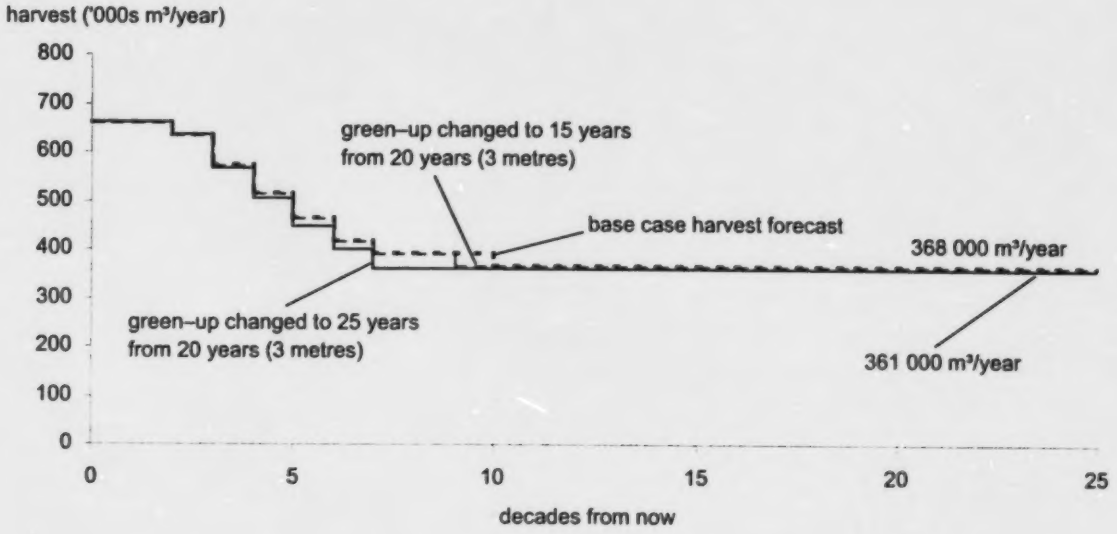


Figure 24. The effect on the harvest forecast of changing the length of time to achieve 3-metre green-up — Lillooet TSA, 2001.

5.8 Uncertainty in the productivity of current old-growth sites after harvest

The productivity of a site largely determines how quickly trees will grow. It therefore affects the timber volumes in regenerated stands, the time to reach green-up and the age at which those stands will reach merchantable size. The most accurate estimates of site productivity come from stands between 30 and 150 years old. At ages less than about 30 years a temporary increase or decrease in growth due to factors such as a post-harvest flush of nutrients or an unusual drought year can affect the overall productivity estimated for the stand. Site productivity estimates derived for older stands may be incorrect because tree heights do not represent actual productivity — for example due to top breakage — and it is very difficult to determine ages of old trees accurately. The results of recent province-wide research suggest that the estimated productivity of sites currently occupied by old-growth stands may be significantly underestimated. Two Old-Growth Site Index (OGSI) studies applicable to timber supply forecasting are:

- *Site index adjustments for old-growth stands based on paired plots* (Nussbaum 1998). Data were obtained from paired plots installed in oid-growth stands and adjacent logged and regenerated stands of the same productivity. Site index was estimated for both and comparisons were made. Results are available for Douglas-fir, lodgepole pine, and interior spruce.
- *Site index adjustments for old-growth stands based on veteran trees* (Nigh 1998). The objective of the study was to develop site index adjustments for species not covered by the paired-plot project. The data for this study came from temporary and permanent plots with a veteran and main stand component. The site indices for the two components were estimated and an adjustment equation for each species was derived using linear regression analysis. The results of the study are considered less reliable than those from the paired-plot study.

The results of these studies are of interest in the Lillooet TSA since stands older than 140 years comprise 40% of the timber harvesting land base. To test the sensitivity of the base case harvest forecast to uncertainty about site productivity estimates, an analysis was performed that incorporated adjustments to site indexes.

OGSI adjustments

Site indices of stands older than 140 years were adjusted using either the paired-plot or veteran-tree results, whichever was applicable. Managed stand volume estimates for those analysis units* affected by changes in estimated future productivity were recalculated based on average adjusted site productivity. Green-up and minimum harvestable ages were also recalculated. Table 5 compares the average forest inventory-based site index for each tree species group to those defined using each of the adjustments.

Table 5. Average analysis unit site index based on forest inventory, paired plot, and veteran plot — Lillooet TSA, 2001

Analysis unit	Timber harvesting land base area (hectares)	Inventory site index	Adjusted site index
Wet Fir — good/medium	2 499	18.3	19.6
Wet Fir — poor	44 886	12.5	16.0
S/B/C/H — good/medium	1 609	17.0	20.5
S/B/C/H — poor	28 497	10.1	17.1
Pine — good/medium	1 623	17.7	21.0
Pine — poor	16 165	12.1	19.1
Wet Fir — PA16	4 610	9.1	10.4
S/B/C/H — PA16	1 524	5.2	6.1
Pine — PA16	31 100	8.8	9.5

Analysis unit
A grouping of types of forest - for example, by species, site productivity, silvicultural treatment, age, and or location, done to simplify analysis and generation of timber yield tables.

- Average site index for the entire Lillooet TSA increased from 12.5 to 14.2 once OGSI adjustments were made.
- Average site index for stands greater than 140 years of age increased form 11.4 to 15.6.

Harvest forecast with OGSI adjustments

- Harvest forecast same as base case for first five decades (Figure 25).
- Long-term harvest level of 486 000 cubic metres per year — 32% above base case — can be maintained from decade 6 onward.

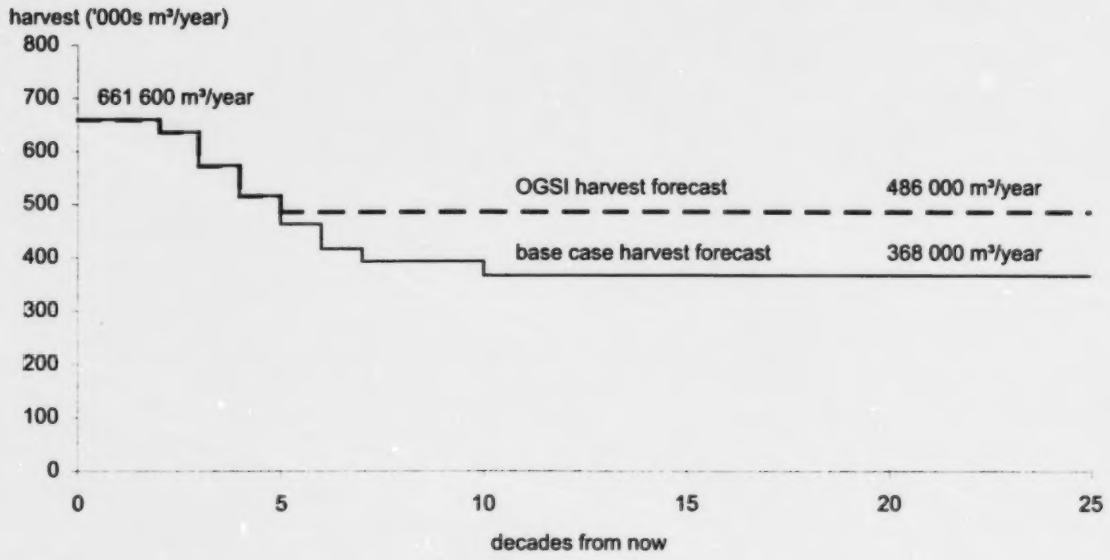


Figure 25. Harvest forecasts based on OGSI (paired plot and veteran studies) site index adjustments — Lillooet TSA, 2001.

Site index adjustments were not included in the base case since there is little local data, and a lack of long-term monitoring data for regenerating stands to validate the adjustments. The results of the sensitivity analysis, however, do provide insight into the trends associated with possible adjustments to site productivity estimates for the Lillooet TSA.

5.9 Alternative harvest queue rules

In the base case, the highest priority for harvest was given to stands that were the oldest relative to their minimum harvestable age. This 'relative oldest first' rule was applied only after other requirements and priorities (e.g., forest cover requirements) were taken into account. This rule reflects the practice of favouring older stands, but not necessarily the oldest, for harvest when all other considerations have been met.

Besides the relative oldest first rule, the Forest Service Simulator (FSSIM) model can also employ absolute oldest first, absolute youngest first, and random scheduling rules. These other rules may better reflect practices in some instances, given unforeseeable operational constraints that may affect when stands are chosen for harvest. Figure 26 shows how timber supply is affected by changing the way harvesting priorities are set.

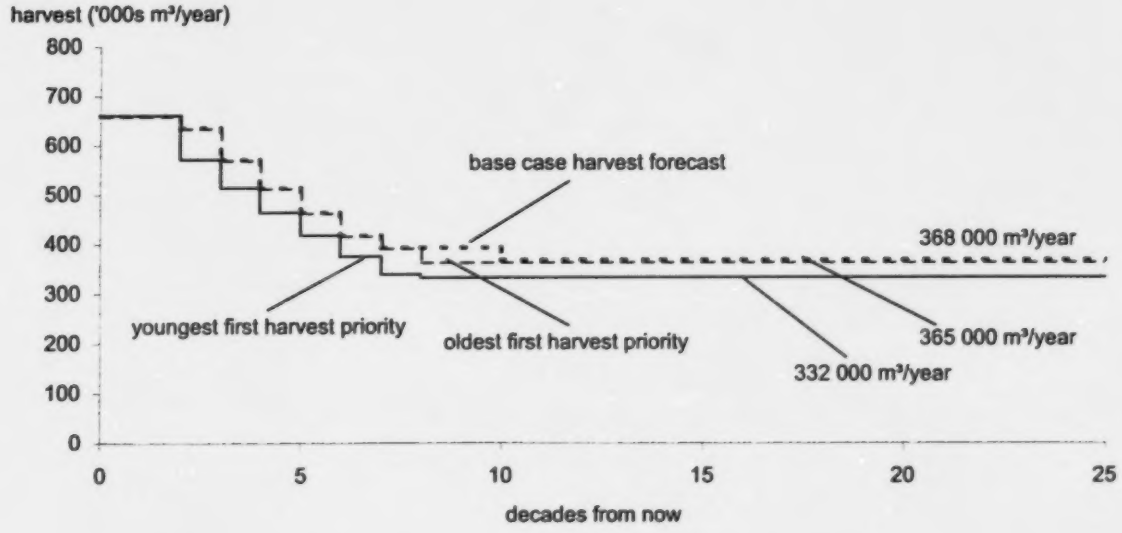


Figure 26. Alternative harvest queue (priority) rules — Lillooet TSA, 2001.

Absolute oldest first rule

- Sets the highest priority on oldest stands.
- Not much effect (minor reduction in ninth and tenth decades) since much of the forest in the Lillooet TSA is currently quite old.

Absolute youngest first rule

- Sets the highest priority on stands that have just reached the minimum harvestable age.
- Base case initial harvest level achievable for only two decades.
- Medium- and long-term supply about 10% lower than base case.
- Harvesting of younger, lower volume stands early in the horizon, which would have accumulated volume if left to age further, together with retention of old stands that are not accumulating volume, combine to decrease supply over the medium term.
- The long-term average harvest age is approximately 100 years, compared to an average of 120 years in the base case.
- Harvesting stands further away from the age of maximum mean annual increment causes a lower long-term harvest level.

5.10 Uncertainty in application of seral stage* retention recommendations

The *Forest Practices Code Act of British Columbia* (FPC) describes the conservation of biodiversity as an essential component of sustainable forest use. The FPC *Landscape Unit Planning Guide* provides recommendation fcr maintaining biodiversity at both the stand- and landscape-levels. Stand-level biodiversity has been addressed in this analysis by a reduction in volume coming from the harvest of each stand. Therefore, uncertainty about stand-level biodiversity can be assessed through sensitivity analysis that examines the changes to existing and managed stand yields.

Management for landscape-level biodiversity was modelled in this analysis through the use of forest cover requirements applied to each combination of natural disturbance type, biogeoclimatic subzone, and variant within each landscape unit. In the base case, old-growth targets, as found in the *Landscape Unit Planning Guide*, were applied at the biogeoclimatic variant level within each draft landscape unit. These targets were a weighted average of the lower, medium and higher biodiversity emphasis option (BEO) targets with 45% assumed as lower, 45% as medium and 10% as higher. In areas subject to the lower BEO, an initial draw down of the old-seral requirements to one-third of the target was allowed in the base case.

While the approach used in the base case represents current policy for managing and modelling landscape-level biodiversity, there is uncertainty about how the recommendations in the *Landscape Unit Planning Guide* will be applied once landscape units and BEOs are declared. As well, the Lillooet LRMP will also be providing recommendations with respect to landscape-level biodiversity.

Three sensitivity analyses were performed to evaluate the potential timber supply impacts associated with uncertainty about landscape-level biodiversity management. Figure 27 shows the results.

Old-seral targets must be met immediately in all landscape unit — biogeoclimatic variant combinations

- Only impact is a dip during the transition between harvest existing- and second-growth (1% less in decade 12 and 5% less in decade 13).

Meet old and mature targets immediately in all biogeoclimatic zone variant combinations

- A dip of during the transition between existing- and second-growth (2% in decade 12 and 9.5% in decade 13).

Meet old- and mature-targets and immediately in all biogeoclimatic zone variant combinations and apply limits on the amount early seral* forest

- No additional impact to the harvest forecast.

Immediate application of old- and mature-forest requirements has essentially no timber supply impact because of the large amount of older forest in the non-timber harvesting land base.

Seral stages
Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.

Early seral
Stands are defined as early seral if they are younger than: 40 years in the Spruce-Willow-Birch (SWB) biogeoclimatic zone; 40 years for coniferous stands; and, 20 years for deciduous stands in the Boreal White and Black Spruce (BWBS) biogeoclimatic zone.

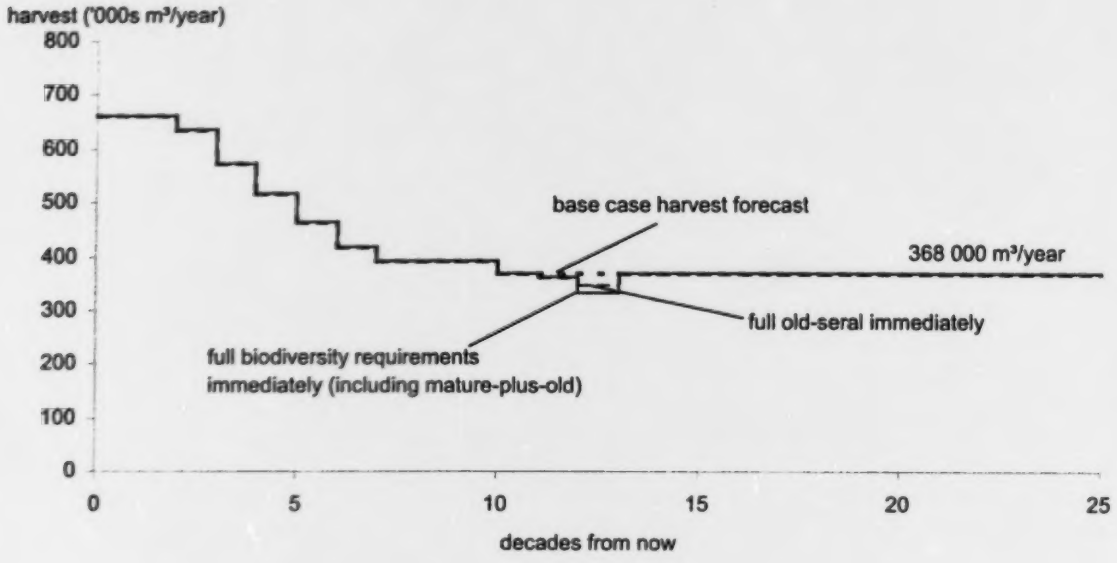


Figure 27. The effect on the harvest forecast of altering biodiversity assumptions — Lillooet TSA, 2001.

5.11 Summary of sensitivity analyses

Table 6 summarizes all sensitivity analyses. Sensitivity analyses showing an increase relative to the base case harvest forecast are presented first, followed by those showing a decrease. Sensitivity analyses showing no impact relative to the base case are presented last.

Table 6. Summary of sensitivity analysis — Lillooet TSA, 2001

Report section	Description	Impact of sensitivity analysis relative to the base case		
		Short term	Medium term	Long term
5.2.1	Increase timber harvesting land base		+	+
5.3	Increase existing stand volumes		+	
5.4	Increase managed stand yields		+	+
5.5	Increase allowable visual disturbance		+	+
5.5	Reduce green-up in visual areas			+
5.6	Reduce minimum harvestable age		+	–
5.8	Old-growth site index adjustments		+	+
5.2.1	Reduce timber harvesting land base		–	–
5.2.2	Constraint contribution of PA 16 land base		–	–
5.3	Reduce existing stand volumes	–	–	
5.4	Reduce managed stand volumes		–	–
5.5	Reduce allowable visual disturbance		–	–
5.5	Increase green-up in visual areas		–	–
5.6	Increase minimum harvestable age		–	+
5.7	Change to a 4-pass system		–	
5.7	Change to a 5-pass system	–	–	+
5.10	Full old seral immediately			–
5.10	Old plus mature immediately			–
5.10	Old, mature, plus early immediately			–
5.7	Increase green-up ages		–	–
5.7	Reduce green-up ages			
5.9	Impact of oldest first harvest priority			–
5.9	Impact of youngest first harvest priority		–	–

6 Summary and Conclusion of the Timber Supply Analysis

The results of this timber supply analysis suggest that, given data and management assumptions that reflect current information and practices, the current allowable harvest level in the Lillooet TSA of 636 600 cubic metres per year can be maintained for a period of up to thirty years. In addition, a harvest level of 25 000 cubic metres per year can be maintained for the fifteen years remaining in the term of Pulpwood Agreement 16. After thirty years, the projected harvest level declines by 10% per decade, reaching a steady level of 368 000 cubic metres per year in 100 years.

A series of sensitivity analysis showed that data and management uncertainties affect timber supply projections to varying degrees, some with positive impacts and others with negative impacts.

Short-term timber supply is sensitive to changes that influence the amount of timber available from existing unmanaged stands, because the harvest forecast relies on harvests from these stands for the next 100 years. The two uncertainties with the largest potential to affect the base case projection of short-term harvest levels (next 20 years) are estimates of timber volumes in existing stands, and the amount of area allowed below green-up height on the timber harvesting land base at any time. An audit conducted in 1997 showed that the inventory estimate of volume in mature stands (over 60 years old) was approximately 12% below the estimate derived from ground samples. Further investigation and sampling has shown that volumes on the non-timber harvesting land base are significantly underestimated by the inventory. However, on the timber harvesting land base portion of the TSA, volumes estimated using inventory information are not statistically different from estimates based on ground measurements.

With respect to current green-up conditions and modelling methods used in the analysis (i.e., limits on the amount of allowable area below green-up), there is no information to suggest inaccuracies. However, sensitivity analysis suggested that timber supply was sensitive to changes in green-up requirements. Short-term timber supply would be reduced substantially relative to the base case if the non-greened-up portion of the timber harvesting land base (i.e., with stands less than 3 metres tall) in each biogeoclimatic variant — landscape unit combination were limited to a maximum of only 20%, rather than 33% as assumed in the base case.

Medium-term (21 to 100 years from now) timber supply is affected by many of the factors tested through sensitivity analysis. Because the long-term harvest level is about 45% lower than the starting harvest level, changes in factors that alter either the total amount of existing volume, or the ability to access existing volume during the first 100 years will affect medium-term timber supply. The medium term is affected by changes in: the size of the timber harvesting land base; volumes from existing stands; minimum harvestable ages; the amount of area allowed below green-up height; old-growth site index estimates, and forest cover requirements for management of visual quality.

Changes in the estimates of volumes in existing stands and in the amount of the land base that is available for harvesting have direct and approximately proportional effects on medium-term supply. In addition, changes in the size of the timber harvesting land base cause proportional increases or decreases in the long term. The substantial sensitivity of short-term timber supply to more limiting green-up requirements (maximum of 20% of the timber harvesting land base younger than green-up age) was also shown in the medium term. Reductions in minimum harvestable ages accelerate availability of regenerated stands thereby increasing the rate that existing stands can be harvested over the medium term. Increases in minimum harvestable ages have the opposite effect. If site productivity is underestimated for existing old-growth stands as suggested by recent research, yields in regenerated stands could be significantly higher than in the base case harvest forecast which would boost long-term supply directly. Medium-term supply would also be increased because the higher volume second-growth stands would be available for harvest sooner than assumed in the base case. Management objectives for visual quality apply on approximately 24% of the timber harvesting land base. Changes to forest cover requirements have small effects on both the medium- and long-term harvest forecast. Further, increasing green-up restrictions for visual quality management, while decreasing short-term supply, can increase supply in the longer term by shifting timber supply into the future.

Another factor with potential impacts on medium- and long-term timber availability is the rule used to set harvest priority. However, the analysis showed significant impacts only when the highest priority was placed on stands that had just reached minimum harvestable age (youngest-first rule), rather than the relative oldest first rule used in the base case. It is unlikely that younger stands would always be given higher harvest priority than older stands. Nevertheless, the analysis showed the potential for changes to harvest priority to have impacts on timber supply.

Long-term (over 100 years from now) timber supply is affected by uncertainties in all the above factors with the exception of changes to existing stand volumes. In addition, changes in managed stand yield estimates have timber supply effects beginning 80 years from now. Higher or lower managed stand yields could have medium-term impacts if they affected minimum harvestable ages; however, analysis of these two factors was separated in the analysis.

The *Lillooet LRMP* has the potential to significantly impact timber supply in the short-, medium-, and long-terms. The *LRMP* is still ongoing, and no specific recommendations have been provided. Hence, there has been no official designation by Cabinet, and the impacts of any eventual recommendations are unknown and have not been included in this analysis. However, the chief forester will consider available LRMP information when making his determination.

In conclusion, this analysis indicates that based on current inventory, growth and yield, and forest management information, timber harvests in the Lillooet TSA can be maintained at the current level for up to 30 years. It is also possible to maintain an additional harvest of 25 000 cubic metres per year over the next 20 years related to Pulpwood Agreement 16. The analysis indicates that several factors related to the current forest inventory and management regime could affect timber supply. However, with the exception of underestimating site indices for old-growth stands, there is no conclusive evidence to suggest that significant inaccuracies exist in the information used in this analysis. Also, the possibility of changes to the land base and forest management practices as a result of the *Lillooet LRMP* will be considered by the chief forester at the time of the AAC determination, if the *LRMP* is approved and implementation details are known.

7 Socio-Economic Analysis

The impact of timber supply adjustments on local communities and the provincial economy is an important consideration in the timber supply review. This socio-economic analysis compares the level of forestry activity currently supported by timber harvested from the Lillooet TSA to the level of activity that could be supported as the timber supply moves towards the long-term harvest level.

The socio-economic analysis examines the short- to long-term harvest levels as projected in the base case harvest forecast and is not intended to examine alternative management scenarios.

The socio-economic analysis consists of the following:

- a profile of the current socio-economic setting;
- a description of the Lillooet TSA forest industry; and
- an analysis of the socio-economic implications of the base case harvest forecast.

7.1 Current socio-economic setting

7.1.1 Overview

This socio-economic analysis focuses on the timber supply from the Lillooet TSA; however, the TSA is part of the larger Lillooet Forest District. The Lillooet Forest District includes a number of parks and reserves. The TSA covers approximately 1.1 million hectares.

7.1.2 Population and demographic trends

The Lillooet TSA includes the communities of Lillooet, Lytton, Bralorne, Gold Bridge and Spences Bridge. There are also numerous Indian Reserves in the area and a significant First Nations population.

According to the 1996 Census, the population of the TSA was 6,538 persons, or less than 1% of the total provincial population. The Village of Lillooet is the largest community (1,988 persons), which leaves the majority (65%) of the local residents living on rural or reserve lands.

The population of the TSA increased by 6.5% between 1991 and 1996. Most of the population gain was in the Village of Lillooet and the rural subdivisions, however the population of Lytton declined slightly. The provincial population growth was 13.5% over the same period.

Since the 1996 Census, the 1999 B.C. STATS estimates that the population of the community of Lillooet (encompasses more than the Village) has fallen from 3,007 persons to an estimated 2,971 persons. The B.C. STATS forecast of population growth for the TSA indicates an average annual growth of 1.5% to the year 2026.

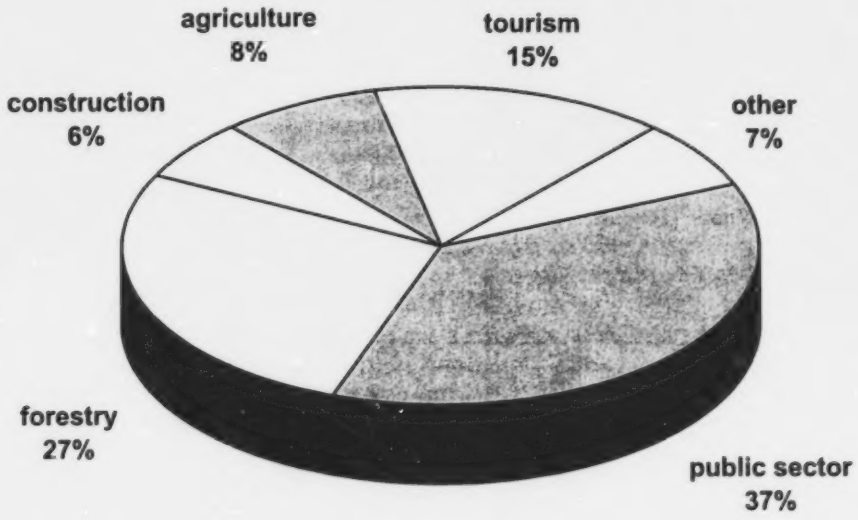
7.1.3 Economic profile

As Figure 28 illustrates, the economy of the Lillooet TSA is primarily forestry-based with 27% of residents' after-tax income derived from forestry-based employment[1]. Other important sectors include the public sector, tourism and agriculture. The unemployment rate in the TSA is higher than the B.C. average. There are two major timber processing facilities in the TSA; Ainsworth Lumber Co. Ltd. lumber and veneer plant in Lillooet, and the Lytton Lumber Ltd. sawmill in Lytton. During 1999, direct forestry-related employment at Lillooet TSA mills accounted for 200 positions.

Tourism ranks second to forestry in terms of private sector contributions to TSA employment (15%) and income (7%). The area supports a wide range of year-round recreation opportunities that draw visitors and supports local employment. These opportunities include: river rafting, backcountry activities, heli-skiing, and motel and food services. Given the area's proximity to the Lower Mainland, the tourism industry has the potential to expand.

(1) The 1996 Forest District Tables, April 1999, Ministry of Finance and Corporate Relations.

The agriculture sector accounts for 8% of the employment and 3% of total after-tax income. In 1996, an estimated 77 farms and ranches were operating in the area. Traditional production includes cattle, hay, hard-skin fruits and vegetables. In recent years, fallow deer, ginseng, and organic vegetables have been added to the local agriculture industry.



Notes: 'Forestry' consists of harvesting-related activities and manufacturing. 'Other' consists of finance, insurance, real estate and other business services. 'Public sector' consists of local and provincial government, health and education.

Source: The 1996 Forest District Tables (April 1999) / Ministry of Finance and Corporate Relations.

Figure 28. Total employment by basic sector, Lillooet TSA, 1996.

The forest sector supports numerous other jobs in the region through companies and employees purchasing goods and services from local businesses. This spending is another indicator of the role forestry has in the economy. Each 100 direct forestry jobs in the Lillooet TSA is estimated to support a further 24 to 40 indirect and induced jobs[2], depending on the type of forestry activity (logging or processing) and the associated level of income. In comparison, each 100 public sector jobs support 12 to 22 additional positions, while each 100 tourism jobs support approximately six to fourteen positions.

7.2 Lillooet TSA forest industry

7.2.1 Current allowable annual cut

In 1996, the current allowable annual cut (AAC) for the Lillooet TSA was set at 643 500 cubic metres. The AAC is apportioned into a number of licence types as outlined in Table 7. There are three replaceable forest licences in the TSA, which account for 73% of the total AAC. The remainder is apportioned to a non-replaceable forest licence, licences under the Small Business Forest Enterprise Program (SBFEP), and other forms of tenures.

(2) Ibid.

Table 7. Allowable annual cut apportionment, by licence type, Lillooet TSA

	AAC apportionment	% of total AAC
Forest licences — replaceable (3)	469 456	73.0
Forest licence — non-replaceable (1)	15 000	2.3
Timber sale licences — replaceable (1)	7 278	1.1
Small Business Forest Enterprise Program (SBFEP)	138 366	21.5
Forest Service reserve	6 500	1.0
Woodlot licences	6 900	1.1
Total AAC	643 500	100.0

Source: Ministry of Forests, 2001

7.2.2 Lillooet TSA harvest history

The actual annual harvest level is an important indicator of forestry activity in the timber supply area. While the AAC is the maximum allowable annual harvest level, the actual volume of timber harvested in a particular year indicates the economic activity supported by the timber supply area. Differences in annual harvest levels are permitted within the limits of cut control[3], which allow licensees to vary their harvest levels based on operating and market conditions. If the actual annual harvest level is consistently less than the AAC then the economic activity is considered to be below its full potential. This gap between actual and allowable harvest activity may influence the potential short-term economic impacts due to any projected changes to the AAC.

From 1996 to 1999, an average of 488 023 cubic metres per year of Crown timber was harvested from the Lillooet TSA. Over the same period, there was additional (outside the TSA) timber harvested from private lands and Indian Reserves, which amounted to about 10 000 cubic metres per year. The Lillooet TSA makes up about 6% of the total allowable annual cut level in the Kamloops Forest Region (8.8 million cubic metres) while the region, in turn, accounts for about 12% of the total provincial harvest (71.5 million cubic metres).

(3) Cut-control provisions allow licensees to vary the volume harvested from the AAC by +/-50% per year, as long as its within +/-10% by the end of a 5-year cut-control period.

Table 8 summarizes the volume of timber harvested in the Lillooet TSA from 1996 to 1999. It indicates a high SBFEP harvest level in 1996 followed by a lower level, slightly increasing, from 1997 to 1999.

Table 8. Volumes billed by licence type, Lillooet TSA, 1996-1999

	(cubic metres)				
Tenure	1996	1997	1998	1999	Average
Forest licences	365 389	280 963	305 763	352 230	326 086
Small Business Forest Enterprise Program (SBFEP)	218 927	68 009	77 099	76 345	110 095
Other[a]	65 035	46 863	52 556	42 913	51 842
Total	649 351	395 835	435 418	471 488	488 023

Source: Ministry of Forests.

(a) Other consists of cutting permits such as right-of-ways, road permits, woodlot licences and other smaller permits.

7.2.3 Lillooet TSA major licensees

Ainsworth Lumber Co. Ltd. (Ainsworth)

Ainsworth has a replaceable forest licence providing the rights to harvest 348 168 cubic metres per year in the Lillooet TSA. Ainsworth has five other licences in the province, which total one million cubic metres per year.

Ainsworth is a Canadian-based manufacturer of forest products with operations in B.C. and Alberta. Products are distributed to markets throughout North America, the Pacific Rim, Europe and South America. Currently, Ainsworth's operations in B.C. include: a lumber and veneer plant in Lillooet; a large oriented strand-board mill and sawmill in the adjoining 100 Mile House TSA; a speciality plywood plant and lumber mill in the adjoining Kamloops TSA; and a finger-joined lumber plant in Abbotsford in the Fraser TSA. The plywood plant in Savona (in the Kamloops TSA) receives 90% of its veneer from the Lillooet mill.

Table 9 outlines Ainsworth's recent harvest activity and 1999 employment levels for its Lillooet TSA operations. Timber harvested from the Lillooet TSA accounts for roughly 100% of Ainsworth's milling requirement for its local mills.

In addition to the forest licences, Ainsworth has Pulpwood Agreement #16, which is partially located within the Lillooet TSA. The total annual harvest is 330 000 cubic metres, of which 25 000 cubic metres is assigned to the Lillooet TSA and the remainder is assigned to the Kamloops, 100 Mile House and Williams Lake TSAs. Currently, the 25 000 cubic metres per year are not included in the AAC for the Lillooet TSA as no harvesting has yet occurred in the TSA under this tenure. The pulpwood agreement only allows this additional timber to be harvested when there is insufficient wood supply for their mills from other sources.

Table 9. Ainsworth Lumber harvest and direct employment statistics

Forest licence AAC	348 168 cubic metres
1999 harvest	240 787 cubic metres
1996-1999 average harvest	237 623 cubic metres
Direct employment (person-years in 1999)	
Harvesting, silviculture and administration	101
Processing	97

Note: The employment figures relate to the volumes harvested from the Lillooet TSA land base only.

J.S. Jones Timber Ltd. (J.S. Jones)

J.S. Jones has a replaceable forest licence providing the rights to harvest 88 510 cubic metres per year in the Lillooet TSA. J.S. Jones also has a replaceable forest licence for 351 880 cubic metres per year in the adjoining Fraser TSA. Table 10 outlines J.S. Jones recent harvest activity and 1999 employment levels for its operations in the Lillooet TSA.

The majority of the timber harvested under the J.S. Jones' licence in the Lillooet TSA is processed at its mill located in Boston Bar (in the adjoining Fraser TSA). The remainder, mostly non-sawlog material, is sold or traded as pulplogs, poles, and houselogs to various other lower mainland processors. Timber harvested from the Lillooet TSA accounts for about 15% of the Boston Bar mill requirements.

In addition, J.S. Jones' has the Stag Timber lumber mill and Teal Cedar Products shake and shingle mill, both located in Surrey (in the Fraser TSA). In 1999, these mills processed over 700 000 cubic metres of timber and employed about 600 individuals.

Table 10. J.S. Jones harvest and direct employment statistics

Forest licence AAC	88 510 cubic metres
1999 harvest	61 360 cubic metres
1996-1999 average harvest	55 816 cubic metres
Direct employment (person-years in 1999)	
Harvesting, silviculture and administration	26
Processing	25

Note: The employment figures relate to the volumes harvested from the Lillooet TSA land base only.

Lytton Lumber Ltd. (Lytton)

Lytton has a replaceable forest licence to harvest 32 778 cubic metres per year in the Lillooet TSA. Table 11 outlines Lytton's recent harvest activity in the TSA and its 1999 employment levels for TSA operations.

Lytton operates a sawmill, and in a joint venture with Kampac Forest Products, a re-manufacturing facility in the Lillooet TSA. Both facilities are located about 3 kilometres south of Lytton. The sawmill began operating in 1963 and the re-manufacturing facility in 1992. Employment at the two operations is about 55 full-time positions (about half are First Nations), and 10 to 15 positions are involved in harvesting (contracted). In addition to its forest licence, Lytton Lumber and/or its joint venture partners from time to time hold non-replaceable licences under the Small Business Forest Enterprise Program, and the mill purchases wood from other sources. The mill is expanding the volume of custom cutting for clients, bringing logs from the interior and the coast. The mill's annual log requirement is about 100 000 cubic metres per year.

Table 11. Lytton Lumber harvest and direct employment statistics

AAC	32 778 cubic metres
1999 harvest	21 352 cubic metres
1996-1999 average harvest	24 788 cubic metres
Direct employment (person-years in 1999)	
Harvesting, silviculture and administration	10
Processing	57

Note: The employment figures relate to the volumes harvested from the Lillooet TSA land base only.

Other licensees

The Cook's Ferry and Siska Indian Bands have partnered with Lytton Lumber Ltd. to create Peyah Forest Products Ltd. Peyah Forest Products has a non-replaceable forest licence with an annual volume of 15 000 cubic metres.

The N'quatqua Logging Company has a replaceable timber sale licence with an annual volume of 7278 cubic metres. The N'quatqua band office (Anderson Lake) is in D'arcy (outside the TSA). The N'quatqua harvest is sold on the Vancouver log market.

There are other licensees that participate in the Small Business Forest Enterprise Program (SBFEP), which has an apportioned level of 138 366 cubic metres per year. From 1996 to 1999, the SBFEP harvest level averaged 110 095 cubic metres per year and supported about 140 direct harvesting, silviculture and processing person-years.

Other processing facilities

There is a value-added mill operated by Bridgeside Higa Forest Industries Ltd. in the Lillooet TSA. This mill has been in operation since 1986 and produces a variety of products for the U.S. and Japanese markets. The mill purchases or exchanges lumber with other facilities and currently processes about 95 000 cubic metres per year. Employment at the mill is currently about 80 person-years, of which 55% are First Nations.

In addition to the processing facilities discussed above, there are a number of smaller mills in the TSA.

7.2.4 Forest sector employment summary

For this section, the preceding harvesting and employment information is considered in the development of employment coefficients used to project future employment levels. For this purpose, the forest sector has been divided into the following three sub-sectors:

- harvesting and other woodlands-related employment such as log transportation and log scaling, and harvest planning;
- silviculture activity including all planting and other basic and intensive operations; and
- primary timber processing employment.

Harvesting and silviculture employment

The harvesting sub-sector of the forest industry includes both company and contract loggers and is the most closely tied to the AAC; consequently, harvest level changes will affect this sub-sector first, and close to the same proportions.

The silviculture sub-sector is less linked to the current level of harvest, since silviculture activities occur at least three to six years after harvesting. Silviculture activity is divided into basic and incremental work. Basic silviculture consists of surveys, site preparation, planting, brushing, cone collecting and some spacing. Incremental, or enhanced silviculture includes spacing, fertilizing, and pruning. In the Lillooet TSA, licensees are responsible for basic silviculture on areas harvested under forest licences. The provincial government is responsible for the remaining basic and all enhanced silviculture on Crown land, which is normally completed by silvicultural contractors.

Primary timber processing employment

The timber harvested from the Lillooet TSA is processed into a variety of products such as lumber, veneer, log homes, pole and posts, and pulp and paper.

Processing facilities in the TSA rely on the timber harvested from the Lillooet TSA and other adjacent TSAs, tree farm licence (TFLs) areas, woodlots, and private lands in the area. Timber from the Lillooet TSA also supports processors located throughout the region and province.

From 1996 to 1999, the Lillooet TSA average harvest level of 488 023 cubic metres per year supported an average of approximately 660 person-years of direct employment across the province.

Forest Service employment

The Lillooet TSA is administered by the B.C. Forest Service staff who work in the Lillooet District office. Currently, about 42 people work in the forest district office. Since Forest Service activities are related more to the administration and enforcement of government policy than to the harvest levels, these jobs are not included in the analysis of forestry sector impacts.

Lillooet TSA forestry employment and employment coefficient summary

Table 12 summarizes employment supported by the 1996 to 1999 average harvest levels in the Lillooet TSA and the corresponding employment coefficients. The employment and coefficients are separated into two groups:

1. TSA employment and employment coefficients, which comprise residents of the Lillooet TSA who are employed within the Lillooet TSA; and
2. provincial employment and employment coefficients, which comprise all forestry sector employment in the province that relies on the Lillooet TSA timber supply; including both residents of the Lillooet TSA and those who live elsewhere.

The coefficients have been calculated for both groups to identify the importance of the forestry sector within the Lillooet TSA and to highlight the contribution that the Lillooet TSA's forestry sector makes to the provincial economy.

7 Socio-Economic Analysis

The coefficients are based on the average annual harvest from the TSA from 1996 to 1999, which was 488 023 cubic metres, only about three-quarters of the current AAC of 643 500 cubic metres.

Table 12. Forestry employment and employment coefficients, Lillooet TSA

Forest industry activity	TSA employment (person-years)	TSA coefficient (person-years/'000s m³)	Provincial employment (person-years)	Provincial coefficient (person-year/'000s m³)
Harvesting and silviculture	191	0.39	212	0.44
Processing	137	0.28	446	0.91
Total direct	328	0.67	659	1.35
Indirect + induced	106	0.22	652	1.34
Total employment	434	0.89	1,311	2.69

Note: Employment estimates are reported in person-years based on average 1996-1999 employment levels and the average annual 1996-1999 harvest of 488 023 cubic metres. Wood products transport, and road building and maintenance are included in the indirect estimates.

For more detailed information regarding employment coefficients see Appendix B, "Socio-Economic Analysis Background Information."

7.2.5 Lillooet TSA employment income

From 1997 to 1998, the average annual income for direct forest sector employees was approximately $48,600 (depending on the type of forestry activity); and $30,300 for indirect and induced employment (in 1998 dollars). Based on these averages, current harvesting, silviculture, and processing of timber from the Lillooet TSA generates an estimated $22.3 million in direct wages and salaries and $15.1 million in indirect and induced wages and salaries, annually throughout the province (see Table 13).

Table 13. Average annual direct and indirect/induced incomes, 1996 - 1998

	Average annual income (1998 dollar value)	Total annual income ($ millions)	Total annual income ($ per '000s m³)
Direct	$48,600	$22.3	$45,699
Indirect / induced	$30,300	$15.1	$30,941
Total income		$37.4	$76,640

Statistics Canada, Survey of Employment Payrolls and Hours.

7.2.6 Provincial government revenues

Provincial government revenues from the forestry industry include stumpage, royalties and rent payments, other taxes such as logging, corporate capital, sales, property and electricity taxes, and income taxes from direct, indirect and induced employees.

From 1996 to 1999, average stumpage and rent payments for Crown timber in the Lillooet TSA were approximately $5.1 million per year. Forest and corporate taxes and revenues generated $3.6 million, while employment supported by the Lillooet timber harvest accounted for $4.4 million in provincial income taxes (see Table 14).

Table 14. Average annual provincial government revenues, 1996-1999

	Average annual revenue 1996-1999 ($1999 millions)	Average annual revenue ($ per '000s m³)
Stumpage, rents and royalties	$5.1	$10,563
Industry taxes	$3.6	$7,426
Provincial income tax	$4.4	$8,913
Total government revenues	$13.1	$26,902

7.3 Socio-economic implications of the base case harvest forecast

The socio-economic implications of the base case harvest forecast focuses on harvest level changes in the short to medium term (up to 40 years from now) and considers:

- the short- and long-term implications of alternative harvest levels for both the Lillooet TSA and the province;
- possible impacts on the communities within the TSA;
- timber requirements of processing facilities within the Lillooet TSA; and
- regional timber supply implications.

The timber supply analysis for the Lillooet TSA indicates that a harvest level of 636 600 cubic metres per year — the current AAC of 643 500 cubic metres less 6900 cubic metres per year for woodlots — could be maintained for the next 30 years. The analysis also shows that the harvest level for the first 20 years could be increased by 25 000 cubic metres per year to 661 600 cubic metres per year. This increase would account for the contribution of the portion of the land base and timber supply covered by Pulpwood Agreement #16 that is located in the Lillooet TSA.

For the purposes of the socio-economic analysis, the projected harvest level of 636 600 cubic metres per year is considered the initial harvest level for the first 30 years, and the additional timber supply of 25 000 cubic metres per year is examined separately.

The socio-economic analysis considers the average levels of forestry activity that the base case harvest forecast could support, assuming that employment changes by the same percentage as the harvest level, and that the proportion of harvesting, processing, and silviculture employment remains the same. Since the analysis also assumes that the types and proportions of products manufactured remain constant, it does not attempt to predict how timber flows, technology or product lines may change in response. The analysis provides an indication of the magnitude of impacts to expect within a constantly changing socio-economic environment.

Employment and income impacts are divided into direct, indirect and induced components; the sum of all the components is the total impact. Direct impacts reflect harvesting, silviculture, and processing activity. Indirect impacts are the result of direct businesses purchasing goods and services, and induced impacts are the result of direct and indirect employees spending their incomes on consumer goods and services.

7.3.1 Short- and long-term implications of alternative harvest levels

Lillooet TSA employment and income impacts

For this analysis, Lillooet TSA employment and income includes only those workers who are supported by the TSA harvest and who reside within the TSA. Workers who come to the TSA to work but who reside outside the TSA are included in the provincial impact section, as is employment supported by the Lillooet TSA timber that is processed at mills outside the TSA.

Table 15 indicates the employment and income that could be supported within the Lillooet TSA by the initial harvest level. If fully harvested and processed, the initial harvest level of 636 600 cubic metres could support approximately 428 person-years of direct employment and another 138 indirect and induced person-years of employment within the TSA, an increase of about 30% over current harvest levels (i.e., 1996 to 1999 average). Approximately $17.5 million (1999 dollar value) total after-tax annual income could be supported by a fully harvested Lillooet timber supply.

By the fourth decade, the initial harvest level is projected to decline by 10% to 572 900 cubic metres per year and could support approximately 385 person-years of direct employment and 124 person-years of indirect and induced employment; an increase of about 17% (approximately 75 person-years) from the 1996 to 1999 average harvest level. Total after-tax employment income would increase from current levels by approximately $1.7 million to $3.0 million per year.

Approximately 90% of all direct employees reside within the Lillooet TSA.

Provincial employment and income impacts

Provincial employment and income impacts include all forest sector employment supported by the timber harvested from the Lillooet TSA. Assuming the initial harvest level of 636 600 cubic metres is fully harvested and processed, the Lillooet TSA can support about 859 person-years of direct forestry employment and a further 850 person-years of indirect and induced employment across the province. By the fourth decade, the lower harvest level of 572 900 cubic metres per year could decrease total employment potential by about 190 person-years from the current AAC, translating into an increase in employment of about 228 person-years based on the current (1996-1999) average harvest levels.

Provincial government revenue impacts

Based on current tax and stumpage rates, the initial harvest level of 636 600 cubic metres has the potential to provide approximately $17.1 million annually to the provincial government (1999 dollar value). As projected in the analysis, by the fourth decade, annual provincial government revenues would decline to about $15.4 million (assuming current taxation and stumpage rates do not change).

7 Socio-Economic Analysis

Table 15. Socio-economic impacts of the Lillooet TSA timber supply forecasts

	At current AAC	PA #16 years 1-20	Initial harvest level forecast years 1-29	Future forecast years 30-39
Timber supply (m^3)				
Current AAC	643 500			
Base case forecast	N/A	25 000	636 600	572 900
Actual harvest level (average 1996-1999)	488 023			
Difference from current AAC	155 477			
Lillooet Timber Supply Area				
Employment			(person-years)	
Direct	328	17	428	385
Indirect / induced	106	5	138	124
Total	434	22	566	509
Cumulative change in total person-years			102-163	48-103
Net employment income			($1999 million)	
Direct	10.9	0.6	14.3	12.9
Indirect / induced	2.5	0.1	3.2	2.9
Total	13.4	0.7	17.5	15.7
Cumulative change in total income			3.4-4.8	1.7-3.0
Province (includes Lillooet TSA)				
Employment			(person-years)	
Direct	659	34	859	773
Indirect / induced	652	33	850	765
Total	1311	67	1709	1538
Cumulative change in total person-years			253-545	96-359
Net employment income			($1999 million)	
Direct	22.3	1.1	29.1	26.2
Indirect / induced	15.1	0.8	19.7	17.7
Total	37.4	1.9	48.8	43.9
Cumulative change in total income			8.0-14.8	3.5-9.6
Provincial government revenues			**($1999 million)**	
Provincial income tax	4.4	0.2	5.7	5.1
Stumpage and rent	5.2	0.3	6.7	6.1
Other B.C. revenues	3.6	0.2	4.7	4.3
Total B.C. revenues	13.2	0.7	17.1	15.4
Cumulative change in total revenue			3.7 – 4.3	2.0 – 2.6

Notes: Provincial employment includes both Lillooet TSA employment and employment supported outside the TSA by Lillooet TSA harvested timber. Income figures in Table 13 are net of taxes while those of Table 15 are gross income.

Table 15 shows estimates of the range of impacts that the various harvest forecasts may have on employment and income. Ranges are utilized to reflect the availability of employment insurance and social assistance payments, and their mitigating effects in the shorter term. In the case of a declining AAC, the lower end of the range reflects induced impacts which are diminished in the short term, because employment insurance and social assistance provide income support to displaced workers. The upper end of the range represents long-term impacts when displaced workers leave the area, and local spending patterns are more fundamentally affected. In reality, a combination of these two scenarios — some workers accessing social assistance payments, some finding alternate employment and some leaving the area completely — is more likely to occur.

7.3.2 Community level impacts

The impacts of short- and long-term changes in timber supply occur within a growing region. The more diversified the region the less effect changes in any one sector will have on the regional economy.

Given that the Lillooet TSA harvest level provides 27% of the basic employment in the TSA, changes to the timber supply would be expected to have a fairly significant impact on the overall economic trends of the region. However, considering that the 1996 to 1999 harvest levels were on average more than 25% below the AAC, the impacts of any potential decline starting in 30 years, could be minimal. Nonetheless, it is anticipated that the harvesting and primary processing components of the forestry industry will decline in the Lillooet TSA over the longer term.

7.3.3 Nature, production capabilities, and timber requirements of processing facilities

The milling requirements of the processing facilities in the Lillooet TSA are about 350 000 cubic metres per year, requirements that are generally met by the timber harvested within the TSA. Since current harvest levels over the last few years have averaged about 25% below the AAC, any future AAC reductions may not have the impact on local processing activity that might be expected. Although the analysis shows a series of reductions, the harvest level projections remain higher than the actual harvest level for at least the next 40 years, based on the 1996 to 1999 average harvest level.

The timber supply in the forest district, which includes a number of woodlots, currently appears to be sufficient to provide timber for local mills currently operating; however, given declining timber supplies in other areas of the province the demand for Lillooet TSA timber, by producers from outside the TSA, may increase significantly.

7.3.4 Regional timber supply implications

Although the timber supply for the Lillooet TSA seems sufficient to meet the needs of the local mills, the future of the regional timber supply is also of primary importance to local processing facilities in the Lillooet TSA. For the Kamloops Forest Region, the previous timber supply review (1992 to 1996) led to a decrease in the conventional AAC of 0.7%, or about 50 000 cubic metres per year. In two to three decades, the annual timber supply from the region may fall by another 2.5%, or 175 000 cubic metres per year, assuming similar forest management practices and timber supply projections.

Nonetheless, mill level impacts do not occur solely as a result of changes in the volume of timber harvested from the local TSA; they also result from harvest changes that occur across the region and the province. It is impossible to predict, however, which mills will be most affected by regional changes, or if new "value added" operations will offset or exacerbate some of these adjustments.

7.4 Summary

The forestry sector is an important source of employment and income for the Lillooet TSA. Residents of the Lillooet TSA account for approximately 90% of the direct forestry employment. The milling requirements of the major processing facilities in the TSA are generally met by the TSA's timber supply.

The socio-economic analysis indicates that the current level of 488 023 cubic metres per year of actual harvesting supports approximately 660 person-years of direct employment across the province and a further 652 indirect and induced jobs.

The initial harvest level for the Lillooet TSA is 636 600 cubic metres per year, which consists of the current AAC less 6900 cubic metres for issued woodlots. This level of harvesting, if fully utilized, could support approximately 859 person-years of direct employment across the province and a further 850 indirect and induced jobs. The timber supply analysis also indicates that the harvest level for the first 20 years could be increased to 661 600 cubic metres per year. This increase would account for 25 000 cubic metres per year currently assigned to the portion of Pulpwood Agreement #16 in the Lillooet TSA which could potentially increase total employment in the province by an additional 67 person-years.

It must be noted that the timber supply analysis is not a recommendation or decision. The chief forester will make the AAC determination based in part on the results of this timber supply and socio-economic analysis.

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9 Glossary

Allowable annual cut (AAC)	The rate of timber harvest permitted each year from a specified area of land, usually expressed as cubic metres of wood per year.
Analysis unit	A grouping of types of forest - for example, by species, site productivity, silvicultural treatment, age, and or location, done to simplify analysis and generation of timber yield tables.
Base case forecast	The timber supply forecast which illustrates the effect of current forest management practices on the timber supply using the best available information, and which forms the reference point for sensitivity analysis.
Biodiversity (biological diversity)	The diversity of plants, animals and other living organisms in all their forms and levels of organization, including the diversity of genes, species and ecosystems, as well as the evolutionary and functional processes that link them.
Biogeoclimatic (BEC) variant	A subdivision of a biogeoclimatic zone. Variants reflect further differences in regional climate and are generally recognized for areas slightly drier, wetter, snowier, warmer or colder than other areas in the subzone.
Biogeoclimatic zones	A large geographic area with broadly homogeneous climate and similar dominant tree species.
Coniferous	Coniferous trees have needles or scale-like leaves and are usually 'evergreen'.
Cutblock	A specific area, with defined boundaries, authorized for harvest.
Cutblock adjacency	The desired spatial relationship among cutblocks. Most adjacency restrictions require that recently harvested areas must achieve a desired condition (green-up) before nearby or adjacent areas can be harvested. Specifications for the maximum allowable proportion of a forested landscape that does not meet green-up requirements are used to approximate the timber supply impacts of adjacency restrictions.
Deciduous	Deciduous trees commonly have broad-leaves and usually shed their leaves annually.
Early seral	Stands are defined as early seral if they are younger than: 40 years in the Spruce-Willow-Birch (SWB) biogeoclimatic zone; 40 years for coniferous stands; and, 20 years for deciduous stands in the Boreal White and Black Spruce (BWBS) biogeoclimatic zone.

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Employment coefficient

The number of person-years of employment supported by every 1000 cubic metres of timber harvested; for example, a coefficient of 1.0 indicates that every 1000 cubic metres harvested supports one person-year, or 500 000 cubic metres supports 500 person-years.

Employment multiplier

An estimate of the total employment supported by each direct job, for example a multiplier of 2.0 means that one direct job supports one additional indirect and induced job.

Environmentally sensitive areas

Areas with significant non-timber values, fragile or unstable soils, or impediments to establishing a new tree crop, or areas where timber harvesting may cause avalanches.

Forest cover objectives

Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see **Cutblock adjacency** and **Green–up**).

Forest cover requirements

Specify desired distributions of areas by age or size class groupings. These objectives can be used to reflect desired conditions for wildlife, watershed protection, visual quality and other integrated resource management objectives. General adjacency and green-up guidelines are also specified using forest cover objectives (see **Cutblock adjacency** and **Green–up**).

Forest inventory

An assessment of British Columbia's timber resources. It includes computerized maps, a database describing the location and nature of forest cover, including size, age, timber volume, and species composition, and a description of other forest values such as recreation and visual quality.

Forest Practices Code

Legislation, standards and guidebooks that govern forest practices and planning, with a focus on ensuring management for all forest values.

Free-growing

An established seedling of an acceptable commercial species that is free from growth-inhibiting brush, weed and excessive tree competition.

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Green-up	The time needed after harvesting for a stand of trees to reach a desired condition (usually a specific height) — to ensure maintenance of water quality, wildlife habitat, soil stability or aesthetics — before harvesting is permitted in adjacent areas.
Growing stock	The volume estimate for all standing timber at a particular time.
Harvest forecast	The flow of potential timber harvests over time. A harvest forecast is usually a measure of the maximum timber supply that can be realized over time for a specified land base and set of management practices. It is a result of forest planning models and is affected by the size and productivity of the land base, the current growing stock, and management objectives, constraints and assumptions.
Inoperable areas	Areas defined as unavailable for harvest for terrain-related or economic reasons. Characteristics used in defining inoperability include slope, topography (e.g., the presence of gullies or exposed rock), difficulty of road access, soil stability, elevation and timber quality. Operability can change over time as a function of changing harvesting technology and economics.
Integrated resource management (IRM)	The identification and consideration of all resource values, including social, economic and environmental needs, in resource planning and decision-making.
Land and Resource Management Plan (LRMP)	A strategic, multi-agency, integrated resource plan at the subregional level. It is based on the principles of enhanced public involvement, consideration of all resource values, consensus-based decision making, and resource sustainability.
Landscape-level biodiversity	The *Landscape Unit Planning Guide* provides objectives for maintaining biodiversity at both the landscape level and the stand level. At the landscape level, guidelines are provided for the maintenance of seral stage distribution, patch size distribution and landscape connectivity.
Landscape unit	A planning area based on topographic or geographic features, that is appropriately sized (up to 100 000 hectares), and designed for application of landscape-level biodiversity objectives.

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Long-term harvest level	A harvest level that can be maintained indefinitely given a particular forest management regime (which defines the timber harvesting land base, and objectives and guidelines for non-timber values) and estimates of timber growth and yield.
Management assumptions	Approximations of management objectives, priorities, constraints and other conditions needed to represent forest management actions in a forest planning model. These include, for example, the criteria for determining the timber harvesting land base, the specification of minimum harvestable ages, utilization levels, integrated resource guidelines and silviculture and pest management programs.
Mean annual increment (MAI)	Stand volume divided by stand age. The age at which average stand growth, or MAI, assumes its maximum is called the culmination age. Harvesting all stands at this age results in a maximum average harvest over the long term.
Model	An abstraction and simplification of reality constructed to help understand an actual system or problem. Forest managers and planners have made extensive use of models, such as maps, classification systems and yield projections, to help direct management activities.
Natural disturbance type (NDT)	An area that is characterized by a natural disturbance regime, such as wildfires, which affects the natural distribution of seral stages. For example areas with less stand-initiating disturbance have more older forests, and generally a greater abundance of species.
Non-merchantable forest types	Stands that are accessible and otherwise available for harvesting but are assumed to be non-merchantable due to stand characteristics such as small piece size, incidence of decay, species composition and low stocking.
Not satisfactorily restocked (NSR) areas	An area not covered by a sufficient number of well spaced tree stems of desirable species. Stocking standards are set by the B.C. Forest Service. Areas harvested prior to October 1987 and not yet sufficiently stocked according to standards are classified as backlog NSR. Areas harvested or otherwise disturbed since October 1987 are classified as current NSR.
Old seral	Old seral refers to forests with appropriate old forest characteristics which provide for biodiversity. Ages vary depending on forest type and biogeoclimatic variant.

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Operability	Classification of an area considered available for timber harvesting. Operability is determined using the terrain characteristics of the area as well as the quality and quantity of timber on the area.
Person-year(s)	One person working the equivalent of one full year, defined as at least 180 days of work. Someone working full-time for 90 days accounts for 0.5 person-years.
Protected area	A designation for areas of land and water set aside to protect natural heritage, cultural heritage or recreational values (may include national park, provincial park, or ecological reserve designations).
Pulpwood agreements	An agreement applying to a fixed geographic area that allows harvesting of timber below sawlog standards if mill residues suitable for the facility under the agreement are not available.
Riparian area	Areas of land adjacent to wetlands or bodies of water such as swamps, streams, rivers or lakes.
Scenic area	Any visually sensitive area or scenic landscape identified through a visual landscape inventory or planning process carried out or approved by a district manager.
Selection management	A silvicultural system used to maintain or create areas containing a wide range of tree ages or sizes. The time interval between harvests in such areas is fairly short (usually less than 30 years), and during these harvests either single scattered trees or small groups of trees are removed from across the entire area.
Sensitivity analysis	A process that examines how uncertainty in data and management assumptions affect timber supply.
Seral stages	Sequential stages in the development of plant communities that successively occupy a site and replace each other over time.
Silvicultural treatments	Activities that ensure the regeneration of young forests on harvested areas, enhance tree growth or improve wood quality in selected stands. Activities include: site rehabilitation and preparation, planting, spacing, fertilization and pruning.
Site index	A measure of site productivity. The indices are reported as the average height, in metres, that the tallest trees in a stand are expected to achieve at 50 years (age is measured at 1.3 metres above the ground). Site index curves have been developed for British Columbia's major commercial tree species.

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Stand-level biodiversity	A stand is a relatively localized and homogeneous land unit that can be managed using a single set of treatments. In stands, objectives for biodiversity are met by maintaining specified stand structure (wildlife trees or patches), vegetation species composition and coarse woody debris levels.
Stocking	The proportion of an area occupied by trees, measured by the degree to which the crowns of adjacent trees touch, and the number of trees per hectare.
Timber harvesting land base	Crown forest land within the timber supply area that is currently considered feasible and economical for timber harvesting.
Timber supply	The amount of timber that is forecast to be available for harvesting over a specified time period, under a particular management regime.
Timber supply area (TSA)	An integrated resource management unit established in accordance with *Section 7* of the *Forest Act*.
Tree farm licence (TFL)	Provides rights to harvest timber, and outlines responsibilities for forest management, in a particular area.
Ungulate	A hoofed-herbivore, such as deer.
Unsalvaged losses	The volume of timber killed or damaged annually by natural causes (e.g., fire, wind, insects and disease) and not harvested.
Variable Density Yield Prediction model	A B.C. Forest Service computer program that generates natural stand yields.
Visual quality objective (VQO)	Defines a level of acceptable landscape alteration resulting from timber harvesting and other activities. A number of visual quality classes have been defined on the basis of the maximum amount of alteration permitted.
Volume estimates (yield projections)	Estimates of yields from forest stands over time. Yield projections can be developed for stand volume, stand diameter or specific products, and for empirical (average stocking), normal (optimal stocking) or managed stands.
Watershed	An area drained by a stream or river. A large watershed may contain several smaller watersheds.

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Wildlife tree

A standing live or dead tree with special characteristics that provide valuable habitat for conservation or enhancement of wildlife.

Woodlot licence

An agreement entered into under the *Forest Act*. It allows for small-scale forestry to be practised in a described area (Crown and private) on a sustained yield basis.

Appendix A

Description of Data Inputs and Assumptions for the Timber Supply Analysis

Introduction

In April of 1999 a data package for the Lillooet Timber Supply Area timber supply review was released for public review. As a result of public input a number of data and management assumptions have been revised. This appendix presents the revised data package used to produce the timber supply analysis.

The following tables and commentary outline the methods and inputs used to derive the timber harvesting land base, and to construct the timber supply model for the Lillooet TSA timber supply analysis. This information represents current forest management in the area. Current management is defined as the set of land use decisions and forest and stand management practices currently implemented and enforced. Future forest management objectives that may be intended, but are not currently implemented and enforced are not included in this appendix. The purpose of the timber supply review is to provide information on the effects of current management on both short- and long-term timber supply in each timber supply area in the province. Any changes in forest management objectives and practices, and any improvements to the data will be included in subsequent timber supply analyses.

A.1 Inventory Information

The inventory information used in this analysis combines the Ministry of Forests (MoF) forest cover inventory for the Lillooet TSA (updated to the end of 1996) with non-standard overlays added to provide information on forest conditions as well as the management considerations listed in Table A-2.

Table A-1. Forest inventory information

Data	Mapsheets / letter block	Year of re-inventory	Re-inventory photo age	Updated to[a]	Projection date
FC1s — Forest cover	**92J**: 038, 048, 058	1997	1993	1997	1997
FC1s — Forest cover	**92I**: 041, 042, 051, 052 **92J**: 039, 049, 050, 059, 060, 067, 068, 070, 079, 080	1990	1987	1996	1997
FC1s — Forest cover	**92I**: 002, 003, 011-014, 022-024, 033, 034, 043, 044, 053, 054, 061, 071, 072, 081, 082, 091, 092 **92J**: 029, 077, 078, 087-090, 097-100 **92O**: 007-010, 017, 018, 019, 020, 028, 029 **92P**: 001	1989	1987	1996	1997
FC1s — Forest cover	**92J**: 056, 065, 066 075, 076, 085, 086, 095, 096 **92O**: 006, 015, 016	1988	1987	1996	1997
FC1s — Forest cover	**92I**: 063	1993	1992	1993	1998
FC1s — Forest cover	**92J**: 057, 069	1990	1987	1990	1997
FC1s — Forest cover	**92I**: 001, 021, 031, 032, 062 **92J**: 010, 019, 020, 030, 040 **92O**: 030 **92P**: 011	1989	1987	1989	1997
FC1s — Forest cover	**92J**: 055, 064, 074, 083, 084, 093, 094 **92O**: 005	1988	1987	1988	1997
FC1s — Forest cover	**92O**: 004	1966	1962	1997	1997
FC1s — Forest cover	**92J**: 072	1991	1990	1991	1997
FC1s — Forest cover	**92J**: 073 **92O**: 025	1977	1975	1988	1997
FC1s — Forest cover	**92J**: 082, 092	1977	1975	1977	1997

(a) The map sheets are updated to the specified year for depletion.

Data source and comments:

All Lillooet Forest District mapsheets have been converted from North American Datum (NAD) 27 to NAD 83 via mono-restitution data capture utilizing 1987 re-inventory document photos and 1993 update photos. Mapsheets 92J 038,92J 048 and 92J 058 were re-inventoried for the Lillooet side of these shared re-inventory projects using 1993 photography accompanied by an update completed at the end of 1996. Mapsheets indicating year of re-inventory and update years of 1977 are inactive partial mapsheets.

A.1 Inventory Information

Table A-2. Non-standard forest inventory information

Data	Source	Date created	Update	Scale
Recreation features inventory	MoF	1994	1994	1:50 000
Visual inventory	MoF	1994	1998	1:50 000
Operability	MoF	1995	1998	1:15 000
Biogeoclimatic ecosystem classifications (BEC)	MoF, Research Branch	1995	1995	1:100 000
Streams and lakes	MELP(TRIM)	1987	1987	1:40 000
Roads	MoF	1993	1997	1:20 000
Community watersheds	MELP, Water Management Branch	1996	1997	1:20 000
Ownership	MoF	1988	1988	1:50 000
Visual quality objectives (VQOs)	MoF	1994	1998	1:20 000
Terrain hazard classification	MoF/FRBC	1997/98	1998	1:20 000
Ungulate winter range	MELP	1997	1997	1:20 000
Draft landscape units	MELP/MoF	1996	1996	1:50 000
Riparian reserves and management areas	MoF	1998	1998	1:20 000
Woodlots	MoF	1988	1996	1:15 000
Protected areas — approved study areas	MoF/MELP	1996	1996	1:30 000
Protected areas	MoF	1995	1996	1:20 000
Stein Park	MoF	1995	1995	1:100 000

A.2 Zone and Analysis Unit Definition

In 1997 an inventory audit was performed for the Lillooet TSA. The final report presented the findings for the mature component (stand age ≥ 60 years) of the timber harvesting land base for the 1995 timber supply analysis. Audit results (50 samples) showed a difference of 20 cubic metres per hectare (+ 9.8%) between the mean audit volume of 218 cubic metres per hectare and mean inventory volume of 198 cubic metres per hectare. The difference of 20 cubic metres per hectare (+ 9.8%) between these two estimates is not statistically significant, 19 times out of 20. The 95% confidence interval for the mean paired difference is – 4 to + 43 cubic metres per hectare. These results indicate that the volume estimates used in TSR 1 were adequate and not a notable source of uncertainty.

The timber harvesting land base for the Lillooet TSA changed significantly since the last timber supply review. As such, the 1997 inventory audit results cannot be applied to the current timber harvesting land base.

A.2.1 Management zones (groups)

For the purpose of modelling current forest management, several resource emphasis groupings were defined for this analysis based on the following forest management objectives:

Table A-3. Group definition

Description	Inventory definition	Function
Landscape-level biodiversity	Non-standard mapped layer of 18 landscape units. The LRMP table has not yet made BEO recommendations.	Application of biodiversity targets using all forested land at the landscape unit / weighted emphasis / BEC zone-variant level.
Visually quality objectives	Non-standard mapped layer with data fields for VQO and visual absorption capacity (VAC).	Using all forested land, each VQO/VAC combination is modelled for each visually sensitive polygon, independently.
Community watersheds	Twenty-one, non-standard mapped layer, MELP defined community watersheds.	Using all forested land, each community watershed is modelled for hydrologic green-up.
Deer winter range thermal cover	Non-standard mapped layer, MELP defined deer winter range.	Application of deer winter range cover across all forested land identified.
Cutblock adjacency	Timber harvesting land base.	Application of adjacency criteria by landscape unit / BEC zone-variant within the timber harvesting land base.

A.2.2 Analysis unit characteristics

An analysis unit represents a combination of stands dominated by specific tree species, a silvicultural regime, or a specific timber growing capacity — as indicated by the inventory type group and site index in the forest inventory file.

Table A-4. shows the variables used to define each analysis unit. A separate timber volume was generated for each analysis unit (see Table A-25. for existing natural stands and Table A-26. for future managed stands). The analysis units are not management zone specific; that is an analysis unit can be in one or more of the management zones described in Section A.2.1, "Management zones (groups)."

A.2 Zone and Analysis Unit Definition

Table A-4. Definition of analysis units

	Analysis unit (leading species)	Criteria			
		Inventory type groups	Biogeoclimatic (BGC) or other criteria as indicated	Site index range (metres)	Age (years)
1.	Douglas-fir (dry belt), selection	1-8, 32-34	IDFxh, IDFdk2b, PP, BG	All	All
2.	Douglas-fir (wet belt), good/medium	1-8, 32-34	All except for IDFxh, IDFdk2b, PP, BG	≥ 17.0	< 141
3.	Douglas-fir (wet belt), poor	1-8, 32-34	All except for IDFxh, IDFdk2b, PP, BG	< 17.0	< 141
4.	Douglas-fir (wet belt), good/medium	1-8, 32-34	All except for IDFxh, IDFdk2b, PP, BG	≥ 17.0	≥ 141
5.	Douglas-fir (wet belt), poor	1-8, 32-34	All except for IDFxh, IDFdk2b, PP, BG	< 17.0	≥ 141
6.	Spruce/balsam/cedar/hemlock, good/medium	9-27	All	≥ 15.0	< 141
7.	Spruce/balsam/cedar/hemlock, poor	9-27	All	< 15.0	< 141
8.	Spruce/balsam/cedar/hemlock, good/medium	9-27	All	≥ 15.0	≥ 141
9.	Spruce/balsam/cedar/hemlock, poor	9-27	All	< 15.0	≥ 141
10.	Lodgepole pine, good/medium	28-31	All	≥ 16.0	< 141
11.	Lodgepole pine, poor	28-31	All	< 16.0	< 141
12.	Lodgepole pine, good/medium	28-31	All	≥ 16.0	≥ 141
13.	Lodgepole Pine, poor	28-31	All	< 16.0	≥ 141
21.	Pulpwood agreement (PA) 16 Douglas-fir (dry belt), selection	1-8, 32-34	IDFxh, IDFdk2b, PP, BG and less than 17 metres in height	All	> 80
22.	PA 16 Douglas-fir (wet belt)	1-8, 32-34	All except for IDFxh, IDFdk2b, PP, BG and less then 17 metres in height	All	> 80
23.	PA 16 spruce/balsam/cedar/hemlock	9-27	Less than 17 metres in height	All	> 80
24.	PA 16 Lodgepole pine	28-31	Less than 17 metres in height	All	> 80
25.	PA 16 Deciduous	35 +	All	All	> 60

A.3 Definition of the Timber Harvesting Land Base

Timber is harvested from only a portion of the total Lillooet TSA area. One of the first steps in this timber supply analysis was to define the timber harvesting land base. This land base was derived by identifying certain types of land and forest where timber harvesting is not likely to occur under current management. The characteristics of each of these types are discussed below in the order in which they were excluded from the timber harvesting base.

A.3.1 Total analysis area

Only area within the Lillooet TSA boundaries is included in the timber supply analysis.

All area on the FIP file coded 61, 62, and 69—which indicates Crown land in a use, recreation and enjoyment of public (UREP) area, forest management unit, or miscellaneous reserve, respectively—is included as area potentially managed by the B.C. Forest Service for contribution to timber supply. Other Crown lands are included for analysis purposes as they contribute to forest values such as biodiversity.

A.3.2 Non-forest

Type identity 6 areas (non-productive land) such as alpine, lakes, rocks, etc., and type identity 8 area (no typing available) are excluded from the land base considered for timber supply. Type identity 8 area, if forested, is included for the land contributing to biodiversity requirements.

A.3.3 Non-commercial cover

Type identity 5 represents areas occupied by non-commercial brush species. These areas are considered to be unlikely sites for timber production and are excluded from the area considered available for timber harvesting.

A.3.4 Inoperable areas

Operability and inoperability codes are generally used to describe the presence or absence of physical barriers or limitations to harvesting, appropriate logging methods (e.g., cable), and the merchantability of stands Operability lines for the Lillooet TSA were originally delineated by the Ministry of Forests, in consultation with licensees, as part of the last inventory update. Inoperable areas are a 100% removal from the timber harvesting land base.

A.3.5 Environmentally sensitive areas

Some forest lands are environmentally sensitive and/or significantly valuable for other resources. These areas are identified and delineated during a forest inventory as environmentally sensitive areas (ESAs). The ESA system uses the following classification: soil (Es), forest regeneration problems (Ep), snow avalanche (Ea), recreation (Er), water (Eh) and wildlife (Ew). Two ESA categories are recognized: high (ESA1) and moderately sensitive (ESA2).

Protection of values in ESAs may result in a reduction in harvesting opportunity. Two strategies for accounting for this are: per cent area reductions, and the specific evaluation of individual ESA polygons for harvesting opportunity. Table A-5 shows the criteria used to account for environmentally sensitive areas in which harvesting is not expected to occur.

A.3 Definition of the Timber Harvesting Land Base

Table A-5. Description of environmentally sensitive areas

ESA category	ESA description	Reduction per cent (%)
Es1	Soils — high	90
Er1	Recreation — high	100
Ea1	Avalanche — high	100
Ew1 & 2	Wildlife	0
Er2 & Es2	Recreation / soils — moderate	0
Ep1 & 2	Regeneration — high / moderate	0
Eh2 & Ef2	Water / fisheries — moderate	0

Where Terrain Stability Mapping is available, it is used in place of Es1. Terrain Class V is 100% netted out, with all other classes remaining eligible for harvesting.

It is assumed that fisheries and water values are adequately protected by the riparian reserves and riparian management areas required by the *Forest Practices Code*.

Previous forest regeneration problem areas are now being regenerated adequately and are not netted out of the productive forest land base.

Wildlife habitat requirements for deer are modelled using forest cover requirements rather than exclusions (see Table A-22.).

Environmentally sensitive area reductions were established by the Ministry of Forests (MoF) staff in collaboration with specialists from the Ministry of Environment, Lands and Parks (MELP). The percentages reflect site sensitivity to forest management, value for other resources, and current management practices.

A.3.6 Sites with low timber growing potential

Sites may have low timber growing potential either because of inherent site factors (nutrient availability, exposure, excessive moisture, etc.) or they are not fully occupied by commercial tree species. The stands excluded from the timber harvesting land base due to low timber growing potential are described in Table A-6. Stands that contribute to Pulpwood Agreement 16 are not subject to low site netdowns. The site index limits are based on a review of harvesting practices for the previous timber supply review, and are believed to reflect current practice.

Table A-6. Description of sites with low timber growing potential

Analysis units	Site index limit (@ 50 years)	Reduction per cent (%)
1 – 5 (Douglas-fir)	< 8.6	100
6 – 9 (Spruce/balsam/cedar)	< 7.5	100
10 – 13 (Lodgepole pine)	< 9.6	100

A.3 Definition of the Timber Harvesting Land Base

A.3.7 Problem forest types

Problem forest types are stands that are physically operable and are not currently utilized or have marginal merchantability. These types are wholly excluded from the timber harvesting land base. Those stands which contribute to the Pulpwood Agreement 16 land base are not subject to these netdowns.

Table A-7. shows the characteristics used to define stands that are not currently being harvested. These criteria are based on review of development plans for the previous timber supply review, adjusted so that stands are either entirely included or entirely excluded from the timber harvesting land base to facilitate mapping of available stands. The criteria reflect current standards of review.

Table A-7. Forest types not currently being harvested

Species	Characteristics	Per cent (%) excluded
Deciduous	All deciduous stands not part of PA 16	100
All coniferous species except fir	All stands classified as residual stocking class	100
Douglas-fir	All age class 6+, height class 1 stands	100
Douglas-fir	All age class 5+, height < 18.0 metres., crown closure class 2 stands	100
Balsam, spruce, cedar, hemlock	All age class 6+, height class 1 stands	100
Cedar, hemlock	All age class 6+, height class 2 stands	100
Whitebark pine	All age class 6+, height < 14.0 metre stands	100
Lodgepole pine	All age class 5+, height < 14.0 metres, stocking class 4 stands	100
Lodgepole pine	All age class 5+, height < 14.0 metres, crown closure class < 5, stocking class other than 4 stands	100
Ponderosa pine	All age class 5+, crown closure class < 5 stands	100

A.3.8 Exclusion of specific, geographically defined areas

Water intakes located within the defined community watersheds were identified from MELP maps. Intakes not already accounted for through exclusions due to ownership codes (e.g., intakes located on Indian Reserve or private land) had a semi-circular 100 metre reserve zone calculated.

Table A-8. Exclusion of specific, geographically defined areas

Location descriptors	Excluded area (hectares)	Reason for exciusion
Water intakes for community watersheds (20 intakes)	1.57 hectares / intake	*Timber Harvesting Practices Regulation* Section 17.1

A.3 Definition of the Timber Harvesting Land Base

A.3.9 Cultural heritage resource reductions

Archaeological overview and cultural heritage value inventories for the entire Lillooet TSA are yet to be completed or are not comprehensive. The impacts of measures required to protect known sites remain unquantified at this time.

A.3.10 Riparian reserve and management zones

A buffering and overlay process in a Geographic Information System (GIS) was employed to deduct geographically specific areas from the productive forest land base to account for riparian areas, as outlined in the following table. The combined riparian zone width, consists of riparian reserve and riparian management zone.

Table A-9. Estimates for riparian reserve and management zones

Riparian classification	Reserve zone (RRZ) width (metre each side)	Management zone (RMZ) width (metre each side)	RMZ maximum basal area retention (%)	Combined riparian zone width
Fraser River (S1)	0	100	50	50
S1 streams	50	20	50	60
S2 streams	30	20	50	40
S3 streams	20	20	50	30
S4 streams	0	30	25	8
S5 streams	0	30	25	8
S6 streams	0	20	5	0
W1 wetlands	10	40	25	20
W2 wetlands	10	20	25	15
W3 wetlands	0	30	25	8
W4 wetlands	0	30	25	8
W5 wetlands	10	40	25	20
L1 lakes > 1000 ha	0	0		0
L1 lakes	10	0	25	10
L2 lakes	10	20	25	15
L3 lakes	0	30	25	8
L4 lakes	0	30	25	8

Riparian zone widths accounted for both the reserve zone and a portion of the management zone according to the recommended maximum basal area retention in each management zone type (ie., a management zone of 20 metres with recommended 50% basal area retention was modeled as a 10-metre reserve zone, which was added to the specific reserve zone for that class of stream, lake or wetland.

A.3 Definition of the Timber Harvesting Land Base

A.3.11 Current roads, trails and landings

Separate estimates are made to reflect the loss in productive forest land due to existing and future roads, trails and landings (RTL). Existing RTL estimates are applied as reductions to the current productive forest considered available for harvesting and future RTL reductions are applied after stands are harvested for the first time in the simulation model. Estimates are applied as the percentages of area to be removed from specified age classes and account only for the area that will be permanently removed from the timber harvesting land base.

The estimate for existing roads, trails and landings are based on a survey of several watersheds (comprising approximately 25 000 hectares) in the Lillooet TSA.

Reductions due to future roads, trails and landings were reduced by 1.5% (9% – 1.5% = 7.5%) to account for already developed access to some second-pass timber by existing mainline roads.

Table A-10. Estimates for existing and future roads, trails and landings

Location	Age class	Reduction area (hectares) or per cent (%)
Existing roads, trails and landings	1 & 2	9.0%
Existing roads, trails and landings	3+	1.5%
Future roads, trails and landings	> 3	7.5%

A.3.12 Wildlife trees (WT) and wildlife tree patches (WTP)

In the Lillooet TSA, stand structure is maintained through three different methods: single tree reserves, wildlife tree patches within cutblocks (WTPs) and wildlife tree patches adjacent to cutblocks (WTOs). Single tree reserves are unlikely to provide harvestable volumes in the future, and are therefore modelled as volume reductions. WTPs are generally less than two hectares in size, and are also unlikely to be harvested in the future, and are modelled as volume reductions. WTOs are generally greater than two hectares in size, and the total area associated with WTOs is considered as contributing towards seral stage requirements and not modelled as a wildlife tree patch constraint.

Table A-11. Reductions to reflect volume retention in cutblocks for wildlife tree patches

Wildlife tree patch type	Persistence	Anticipated harvest activity	Per cent (%) of annual harvested volumes
Single tree	Permanent	No	0.5
WTP	Permanent	No	5.3
WTO	Not persistent		4.9

Estimates of volumes retained in single tree reserves and wildlife tree patches were derived for the Lillooet Forest District. The percentages apply to the timber harvesting land base, that is, the volume of timber retained on harvestable area. This data was compiled from a review of development plans and silviculture prescriptions. Additional work is being undertaken to determine if the areas being left as wildlife tree patches are representative of the areas being harvested.

A.3 Definition of the Timber Harvesting Land Base

A.3.13 Not satisfactorily restocked (NSR) areas

Some land classified in the Lillooet TSA inventory file as type identity 4 or 9 is included in the timber harvesting land base. These type identities indicate not satisfactorily restocked (NSR) land base. The purpose of this section is to identify the total area of NSR in the timber harvesting land base, and the estimated rate at which the NSR area will be restocked. Figures on the inventory file have been adjusted to match the figures provided in the following table (from the forest district silviculture records).

Table A-12. Not satisfactorily restocked (NSR) areas

Forest district	Backlog NSR area (hectares)	Current NSR area (hectares)
Lillooet Forest District	766	2 771

The data for backlog NSR was derived from the Integrated Silviculture Information System (ISIS) and the Major Licensee Silviculture Information System (MLSIS). Current NSR reflects roughly 1.5 years of harvest area, which has not yet been planted and is scheduled to achieve stocking within standard regeneration delays. Backlog NSR target date to be restocked is the year 2001, which is reflected in the base case.

A.4 Forest Management Assumptions

A.4.1 Utilization levels

The utilization level defines the maximum stump height, minimum top diameter inside bark and minimum diameter at breast height (1.3 metres) by species and is used in the analysis to calculate merchantable volume.

Table A.13. reflects current regional standards, licence requirements and current performance, except for Pulpwood Agreement 16, part of which overlaps with the Lillooet TSA. The PA has different utilization standards; however they were not reflected in the analysis because of the difficulty in applying those standards in existing yield models, as well as the small effect the different standards would have on stand volumes. No harvesting has yet taken place in PA 16.

Table A-13. Utilization levels

Analysis unit	Utilization		
	Minimum dbh (cm)	Maximum stump height (cm)	Minimum top dib (cm)
Lodgepole pine	12.5	30	10
All other coniferous species	17.5	30	10

A.4.2 Volume exclusions for mixed species stands

The volumes of any species in mixed species stands that are not utilized were excluded from volume projections. For example, in the Lillooet TSA, the deciduous species in predominantly coniferous stands outside of Pulpwood Agreement 16 are not harvested. Table A-14. shows the species for which volumes were excluded from the estimation of stand volume.

Table A-14. Volume exclusions for mixed species types

Species	Volume exclusion (%)
Whitebark pine	100
All deciduous volumes in all analysis units except PA16	100

A.4.3 Minimum harvestable age derivation

Minimum harvestable age defines the earliest age at which a stand may be harvested. Harvesting may occur once a stand has reached the minimum requirements to achieve goals such as maintaining overall harvest levels for a short period of time or avoiding large fluctuations in harvest levels.

Minimum harvestable ages for existing stands are regional standards. Given the current age class distribution in the Lillooet TSA, most existing stands will not be harvested until well past the minimum harvestable ages. Minimum harvestable ages for future, managed stands were based on the culmination (maximum) of mean annual increment. Once stands reached 90% of the maximum mean annual increment age they are assumed to be available for timber harvest. Table A-15. shows minimum harvestable ages for each analysis unit.

A.4 Forest Management Assumptions

Table A-15. Minimum harvestable ages

Analysis unit	Species	Minimum harvestable age existing	Minimum harvestable age future
Existing – AU 1 Future – AU 51	Existing and future Douglas-fir selection	100	100
Existing – AU 2 Future – AU 52	Existing Douglas-fir good / medium, < 141	80	80
Existing – AU 3 Future – AU 53	Existing Douglas-fir poor, < 141	80	100
Existing – AU 4 Future – AU 54	Existing Douglas-fir good / medium, > 140	80	80
Existing – AU 5 Future – AU 55	Existing Douglas-fir poor, > 140	80	110
Existing – AU 6 Future – AU 56	Existing spruce / balsam / cedar / hemlock, good / medium, < 141	100	90
Existing – AU 7 Future – AU 57	Existing spruce / balsam / cedar / hemlock, poor, < 141	100	120
Existing – AU 8 Future – AU 58	Existing spruce / balsam / cedar / hemlock, good / medium, > 140	100	80
Existing – AU 9 Future – AU 59	Existing spruce / balsam / cedar / hemlock, poor, > 140	100	130
Existing – AU 10 Future – AU 60	Existing lodgepole pine, good / medium, < 141	80	70
Existing – AU 11 Future – AU 61	Existing lodgepole pine, poor, < 141	80	90
Existing – AU 12 Future – AU 62	Existing lodgepole pine, good / medium, > 140	80	70
Existing – AU 13 Future – AU 63	Existing lodgepole pine, poor, > 140	80	130
Existing – AU 21 Future – AU 71	Pulpwood Agreement (PA) 16 Douglas-fir (dry belt), selection	100	100
Existing – AU 22 Future – AU 72	PA 16 Douglas-fir (wet belt)	80	150
Existing – AU 23 Future – AU 73	PA 16 spruce / balsam / cedar / hemlock	80	240[a]
Existing – AU 24 Future – AU 74	PA 16 lodgepole pine	80	110
Existing – AU 25 Future – AU 25	PA 16 deciduous	60	60

Note: (a) While the minimum harvestable age for analysis unit 73 is very old, this forest type comprises only 1500 hectares of the timber harvesting land base, which is well under 1% of the harvestable area. The maximum MAI for the unit is 0.57 m^3/ha/yr.

A.4 Forest Management Assumptions

A.4.4 Unsalvaged losses

Table A-16. shows the estimated average annual unsalvaged volume loss to catastrophic events such as insect epidemics, fires, wind damage or other agents over the long term on the timber harvesting land base. The unsalvaged loss column only reflects those areas in which the volume will not be recovered or salvaged.

Table A-16. Unsalvaged losses

Cause of loss	Annual unsalvaged loss (m^3/year)
Insects	4 134
Fire	12 746
Windthrow	8 200
Miscellaneous	1 000
Total	26 080

Current and projected volume losses can be expected in Douglas-fir stands due to the Western Spruce Budworm. Historic and endemic Mountain Pine Beetle and Spruce Bark Beetle losses have been accounted for in the district inventory. It is expected that future unsalvaged losses to these insects will be minimal within the operable land base.

Unsalvaged losses due to fire are based on 10 years of district fire reports and are reduced by 50% to account for the incidence of fire in problem forest types and stands located on inoperable ground.

Windthrow losses account for small isolated patches or individual trees on the edge of a cutblock that may blowdown but are not salvaged.

Miscellaneous losses relate to landslide areas and other minor factors.

A.4.5 Basic silviculture and regeneration assumptions

In the Lillooet TSA, basic silviculture is assumed to be carried out on all sites. Table A-17. shows the proportion of each analysis unit to be treated under each silviculture regime and the expected average regeneration delay.

Recent plantations and future stands are grown on managed stand yield tables (MSYTs) produced using the B.C. Forest Service table interpolation program for stand yields (TIPSY) growth and yield model. A MSYT was built from a number of tables if more than one regeneration method was used within an analysis unit. When this is the case, tables have been produced for the different regeneration methods (each method and species combination) are then aggregated into one table.

A.4 Forest Management Assumptions

Table A-17. Regeneration assumptions by analysis unit

Analysis unit	Leading species	Site class / age	Regen delay (years)	Method		Density (planted)		
				Type	%	Species	Spp. %	Stems / hectare
2	Fir / Wet	G/M < 141	3	Plant	100	Fd Pl	80 20	1000 1400
3	Fir / Wet	P < 141	3	Plant	100	Fd Pl	60 40	1000 1200
4	Fir / Wet	G/M ≥ 141	3	Plant	100	Fd Pl	80 20	1000 1400
5	Fir / Wet	P ≥ 141	3	Plant	100	Fd Pl	60 40	1000 1200
6	Sx/Bl/Cw/H	G/M < 141	3	Plant	100	Sx Pl	70 30	1200 1400
7	Sx/Bl/Cw/H	P < 141	3	Plant	100	Sx Pl	70 30	1000 1200
8	Sx/Bl/Cw/H	G/M ≥ 141	3	Plant	100	Sx Pl	70 30	1200 1400
9	Sx/Bl/Cw/H	P ≥ 141	3	Plant	100	Sx Pl	70 30	1000 1200
10	Pl	G/M < 141	3	Plant	100	Pl Sx	90 10	1400 1200
11	Pl	P < 141	4	Plant Natural	80 20	Pl Pl	100 100	1200 1000
12	Pl	G/M ≥ 141	3	Plant	100	Pl Sx	90 10	1400 1200
13	Pl	P ≥ 141	4	Plant Natural	80 20	Pl Pl	100 100	1200 1000
22	Fir / Wet	PA 16	3	Plant	100	Fd Pl	60 40	1000 1200
23	Sx/Bl/Cw/H	PA 16	3	Plant	100	Sx Pl	70 30	1000 1200
24	Pl	PA 16	4	Plant Natural	80 20	Pl Pl	100 100	1200 1000

A.4 Forest Management Assumptions

All values in Table A-17. are based on current performance as estimated by the Lillooet Forest District staff. Age of planting stock is estimated at one year on average, and has been subtracted from the regeneration delay. Operational adjustment factors (OAF) of 15% and 5% have been applied to all managed stand yield curves to account for natural spatial patchiness and other factors that lead to small stocking gaps (OAF 1), and for losses that increase with age (OAF 2); for example, decay, waste and breakage. Deciduous analysis units are regenerated back to their existing yield curve.

A.4.6 Immature plantation history

For this analysis, stands with a history of density control and stand tending were considered managed stands. All stands younger than 21 years are considered managed, and a percentage of stands 21-40 years were assigned to managed stand yield curves. Input from District silviculture staff and licensees was used in approximating areas managed by analysis unit for stands aged 21 – 30 years and 31 – 40 years.

Table A-18. Immature plantation history

Analysis unit	Area managed – per cent (%)		
	Age 1-20	Age 21-30	Age 31-40
Douglas-fir good / medium	100	80	50
Douglas-fir poor	100	50	25
Spruce / balsam / cedar / hemlock, good / medium	100	80	50
Spruce / balsam / cedar / hemlock, poor	100	50	50
Lodgepole pine good / medium	100	80	50
Lodgepole pine poor	100	50	30

A.4.7 Harvest scheduling priorities

Generally, older available stands are favoured for harvesting when all other objectives have been met. Table A-19. reflects average per cent harvested by species in the Lillooet TSA, over the last 5 years.

Table A-19. Harvest scheduling history

Analysis units	Species	Per cent (%) of total harvest over last 5 years
1	Douglas-fir (dry belt)	8
2 – 5	Douglas-fir (wet belt)	17
6 – 9	Balsam, spruce, cedar, hemlock	46
10 – 13	Lodgepole pine	29

Figures in the above table are historic volume based harvest profiles and are presented for information purposes only at this time.

A.4 Forest Management Assumptions

A.4.8 Logging methods and silvicultural systems

The following table shows the logging methods currently in use in the Lillooet TSA. In the past 4 years the proportion of cable and helicopter harvest has been increasing.

Table A-20. Logging method

Logging method	Per cent (%) of total annual harvest
Skidder	53.5
Cable	38.2
Helicopter	3.3

The above table, based on data going back to 1990, is supplied by licensees and from ISIS. It is for information purposes only at this time. If the past 4 years data were used only, the cable proportion would be 48.6 % and the helicopter harvest would be 4.5% of the total harvest.

Table A-21. lists the silvicultural systems currently used in the TSA and the respective silvicultural regime.

Table A-21. Silvicultural systems

Silvicultural system	Per cent (%) of harvest (by area)	Per cent (%) retention	Number of entries	Time between entries (years)
Clearcut	72.6	0	1	Full rotation
Seed tree	8.8	< 1	1	Full rotation
Shelterwood	4.5	66	3	30
Selection	14.1	40 – 75	Up to 4	30

This table describes the district wide historic proportion of the annual harvest, since 1987, by silvicultural system and is based on ISIS and supplementary data supplied by licensees. In selection systems, it is assumed that 40% of the existing volume is removed on the first pass. Additional harvests can begin after 30 years and will remove volume equivalent to 30% of the original standing volume.

A.4.9 Forest cover requirements — resource management zones

In the Lillooet TSA, removal of forest cover is limited to manage for water quality in community watersheds, for visual quality, for critical wildlife habitat and for landscape- and stand-level biodiversity. Forest that does not contribute to the timber harvesting land base helps in achieving forest cover requirements for some objectives, as noted in the last column of Table A-22. Forest outside the timber harvesting land base also contributes to biodiversity.

The following forest cover requirements are applied to each resource emphasis group or zone.

A.4 Forest Management Assumptions

Table A-22. Forest cover requirements

Management zone	Forest cover objectives		Minimum older age (years)	Minimum area of older age retained (%)	Land base constraints apply to
	Green-up height (metres)	Green-up maximum allowable disturbance (%)			
Community watersheds	6.6 metres (33 years)	20			Crown forested land base within each watershed
Visually sensitive	Refer to Table A-23				Crown forested land base within each visual polygon
Critical deer winter range			80	20	Crown forested land base in the critical range
Standard management	3.0 metres (20 years)	33			Timber harvesting land base within each BEC variant

Visually sensitive areas have constraints determined for each polygon, according to the procedures set out in Table A-23. Critical deer winter range area is managed to ensure sufficient thermal cover is maintained. At least 20% of the gross forest area must be greater than 80 years of age. The standard management zone assumes a 3-pass harvesting sequence, requiring no more than 33% of the timber harvesting land base less than three metres in height within each landscape unit, BEC variant combination.

Table A-23. Forest cover requirements for visually sensitive areas.

Visual quality objective	Low VAC			Intermediate VAC			High VAC		
	Green-up height (metres)	% removal range	% removal mid-point	Green-up height (metres)	% removal range	% removal mid-point	Green-up height (metres)	% removal range	% removal mid-point
Preservation	3	1	1	3	2	2	3	3	3
Retention	5	3-4.5	3.8	4	4.5-6.5	5.5	3	6.5-8	7.2
Partial retention	5	8-12	10	4	12-16	14	3	16-20	18
Modification	5	15-20	17.5	4	20-25	22.5	3	25-30	27.5

A.4 Forest Management Assumptions

Constraints for visually sensitive areas have been determined for each visually sensitive polygon, based on the *Kamloops Land and Resource Management Plan VQO Matrix*, modified for the Lillooet Forest District current management practices. The range of maximum per cent area removal (maximum per cent area below visual green-up height) was determined based on the existing visual absorption capacity and the visual quality objective for each polygon. The mid-point of this per cent removal range was determined for each VQO polygon, and each polygon was modelled separately in the analysis.

A.4.10 Forest cover requirements – landscape-level biodiversity

Management for biodiversity is a requirement under the Forest Practices Code. To protect biodiversity at the landscape level, old growth forest is retained in every landscape unit and natural disturbance type (NDT). Table A-24. summarizes the percentage of old forest required for each NDT modelled in this analysis. Requirements for retention of mature forest and constraints on early seral forest were considered in the sensitivity analysis.

Table A-24. Old-seral requirements by landscape unit and natural disturbance type (NDT)

		Old seral stage % area retention by minimum age					
NDT	Biogeoclimatic unit	Minimum age (years)	Low emphasis Time 0	Low emphasis Time 160	Low emphasis Time 240	Intermediate emphasis	High emphasis
2	CWH	250	3	6	9	9	13
2	ESSF	250	3	6	9	9	13
3	ESSF	140	5	10	14	14	21
3	MS	140	5	10	14	14	21
4	PP	250	5	9	13	13	19
4	BG	N/A	N/A	N/A	N/A	N/A	N/A
4	IDF	250	5	9	13	13	19

The percentages for old forest retention are based on recommendations in the *Biodiversity Guidebook*. These percentages were pro-rated consistent with the assumption that biodiversity emphasis options (BEOs) of high, intermediate and lower will ultimately to distributed across 10%-45%-45% of the land base, respectively. The pro-rated requirements were applied to each biogeoclimatic variant and NDT in each landscape unit. In keeping with the Deputy Minister's letter of August 27, 1997, and the *Landscape Unit Planning Guide* of March, 1999, landscape units assigned a Low BEO have three rotations to meet the old forest retention requirements.

A.5 Volume Estimates for Existing Stands

The variable density yield prediction (VDYP) model, version 6.4a developed and supported by the B.C. Ministry of Forests, Resources Inventory Branch, was used to estimate timber volumes for existing natural stands. Table A-25. shows the volume estimates by analysis unit for existing natural stands.

Table A-25. Timber volume tables for existing natural stands (cubic metres)

Table	1	2	3	4	5	6	7
Age	Dry Fir Selection	Fir Wet G/M	Fir Wet P	Fir Wet G/M, 8+	Fir Wet P, 8+	S/B/C/H G/M	S/B/C/H P
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.06	2.51	0.01	0.92	0.01	1.73	0.00
40	0.71	29.19	1.25	23.67	0.64	18.13	1.63
50	3.01	65.62	11.27	57.69	6.75	56.58	8.64
60	7.74	102.03	28.89	91.57	19.94	104.30	24.19
70	13.88	137.60	48.96	124.67	36.51	149.24	48.92
80	20.29	171.92	68.95	156.60	53.76	188.75	74.55
90	26.62	204.58	88.37	186.98	70.79	223.31	99.68
100	32.75	235.39	107.11	215.87	87.28	253.9?	123.35
110	38.63	263.88	125.14	243.10	103.18	281.16	145.38
120	43.86	288.51	141.19	266.61	117.38	305.21	165.70
130	48.78	311.41	156.36	288.70	130.84	329.06	186.26
140	53.26	331.21	169.62	308.26	142.84	349.70	204.88
150	57.32	348.81	181.36	325.86	153.62	367.93	221.93
160	60.96	364.39	191.58	341.66	163.18	384.1	237.48
170	64.20	378.14	200.31	355.83	171.52	398.43	251.66
180	67.46	390.78	208.93	369.34	179.83	411.21	264.59
190	70.57	402.14	216.85	381.85	187.61	422.51	276.34
200	73.58	413.35	224.84	393.70	195.33	433.58	287.87
210	76.46	423.93	232.50	404.87	202.73	443.96	298.86
220	79.19	433.95	239.83	415.40	209.79	453.67	309.31
230	81.80	443.45	246.82	425.36	216.52	462.79	319.22
240	84.29	452.44	253.49	434.84	222.94	471.35	328.65
250	86.67	460.99	259.84	443.87	229.06	479.40	337.62
260		461.24	260.09	444.37	229.33	482.44	341.28
270		461.43	260.29	444.82	229.57	485.19	344.68
280		461.57	260.45	445.24	229.77	487.71	347.83
290		461.67	260.56	445.62	229.94	490.01	350.76
300		461.73	260.64	445.95	230.09	492.10	353.47
310		461.73	260.67	446.26	230.19	493.99	355.98
320		461.68	260.66	446.54	230.27	495.69	358.28
330		461.59	260.61	446.77	230.32	497.26	360.41
340		461.44	260.52	446.96	230.34	498.66	362.37
350		461.21	260.39	447.13	230.32	499.93	364.17

(continued)

A.5 Volume Estimates for Existing Stands

Table A-25. Timber volume tables for existing natural stands (cubic metres) (continued)

Table	8	9	10	11	12	13
Age	S/B/C/H G/M, 8+	S/B/C/H P, 8+	Pine G/M	Pine P	Pine G/M, 8+	Pine P, 8+
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.19	0.03	0.38	0.06
30	0.25	0.00	12.75	0.23	12.35	0.55
40	8.22	0.50	63.29	9.18	64.12	7.45
50	42.69	4.07	110.09	36.02	110.68	28.77
60	93.12	13.6	151.49	66.24	151.55	58.31
70	138.92	31.64	188.16	94.18	187.48	86.14
80	179.32	52.85	220.77	119.80	219.24	111.59
90	214.35	76.24	250.89	143.88	248.18	135.31
100	244.93	99.44	278.49	166.38	274.48	157.38
110	271.62	121.01	303.94	187.45	298.48	177.96
120	294.80	140.95	327.57	207.26	320.64	197.25
130	316.81	160.88	349.96	226.13	341.66	215.71
140	336.08	179.22	364.86	239.32	355.99	228.97
150	353.01	196.18	376.46	249.86	367.28	239.71
160	367.92	211.82	384.78	257.74	375.56	247.95
170	381.08	226.22	389.86	263.01	380.93	253.73
180	392.83	239.48	391.71	265.64	383.35	257.05
190	403.24	251.66	390.34	265.68	382.87	257.94
200	413.02	263.42	392.89	268.47	385.76	261.22
210	421.97	274.56	395.75	271.41	388.87	264.55
220	430.19	285.11	398.70	274.32	392.00	267.81
230	437.75	295.09	401.63	277.12	395.05	270.91
240	444.69	304.56	404.46	279.77	398.00	273.83
250	451.09	313.54	407.15	282.25	400.78	276.54
260	454.47	317.81	409.24	284.15	402.84	278.64
270	457.51	321.78	411.19	285.89	404.73	280.56
280	460.26	325.46	413.00	287.46	406.48	282.29
290	462.71	328.88	414.65	288.85	408.08	283.85
300	464.93	332.05	416.15	290.09	409.56	285.24
310	466.89	334.99	417.50	291.16	410.85	286.44
320	468.63	337.71	418.70	292.07	412.03	287.48
330	470.18	340.22	419.75	292.82	413.07	288.37
340	471.55	342.53	420.66	293.43	413.95	289.10
350	472.75	344.66	421.43	293.88	414.73	289.67

(continued)

A.5 Volume Estimates for Existing Stands

Table A-25. Timber volume tables for existing natural stands (cubic metres) (concluded)

Table	21	22	23	24	25
Age	Dry Fir Selection PA 16	Fir Wet PA 16	S/B/C/H PA 16	Pine PA 16	Deciduous PA 16
10	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.02	0.00
40	0.00	0.02	0.18	0.13	2.43
50	0.15	1.89	0.66	4.35	9.15
60	1.00	8.38	1.48	14.44	22.53
70	3.06	17.80	3.89	27.07	37.99
80	5.92	28.09	7.61	40.84	51.15
90	8.99	38.60	13.47	55.34	62.85
100	12.06	48.96	20.27	69.62	73.07
110	14.96	58.77	27.36	83.54	81.78
120	17.66	68.00	34.62	97.03	88.77
130	20.20	76.75	43.87	110.08	94.07
140	22.54	84.53	53.71	119.85	99.07
150	24.71	91.64	63.65	127.89	103.49
160	26.74	98.11	73.24	134.20	105.42
170	28.62	103.96	82.31	138.80	107.17
180	30.36	109.23	91.00	141.70	108.74
190	31.98	113.94	99.20	142.88	110.19
200	33.52	118.67	107.16	145.48	111.53
210	34.96	123.18	114.88	148.08	112.82
220	36.32	127.50	122.33	150.58	114.03
230	37.60	131.59	129.53	152.92	115.18
240	38.81	135.49	136.49	155.11	116.26
250	39.96	139.23	143.18	157.12	117.29
260		139.45	148.23	158.84	117.55
270		139.65	153.08	160.40	117.81
280		139.83	157.72	161.78	118.05
290		139.99	162.22	163.01	118.27
300		140.12	166.58	164.09	118.46
310		140.23	170.74	165	118.65
320		140.32	174.71	165.78	118.82
330		140.38	178.52	166.41	118.98
340		140.43	182.18	166.91	119.12
350		140.46	185.68	167.26	119.24

A.6 Volume Estimates for Regenerated Stands

WinTIPSY (Windows™ version of the Table Interpolation Program for Stand Yields) version 1.4, supported by the B.C. Ministry of Forests, Research Branch, was used to estimate growth and yield for existing and future managed stands. The area-weighted site index and regeneration assumptions for each analysis unit were used as inputs to TIPSY. Section A.4.5, "Immature plantation history" and Table A-17. document which stands are assumed to be managed in the analysis.

Operational adjustment factors (OAFs) used in managed stand yield table generation were:

OAF1 of 15% (a constant percentage reduction at all ages to represent incomplete site occupancy, for example, small holes in a stand), and;

OAF2 of 5% (an increasing reduction, to represent losses such as decay that increase with stand age).

Table A-26. displays the volume tables for managed stands. Volumes are assumed to remain constant after 250 years of age or the age after which no further data were available.

Table A-26. Timber volume tables for managed stands (cubic metres)

Table	51	52	53	54	55	56	57
Age	Dry Fir Selection	Fir Wet G/M	Fir Wet P	Fir Wet G/M, 8+	Fir Wet P, 8+	S/B/C/H G/M	S/B/C/H P
10	0.00	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00	0.00
30	0.04	3.00	0.00	3.00	0.00	1.00	0.00
40	0.53	22.00	2.00	22.00	1.00	10.00	1.00
50	2.26	62.00	12.00	63.00	8.00	46.00	5.00
60	5.80	114.00	33.00	115.00	21.00	101.00	15.00
70	10.41	166.00	57.00	167.00	42.00	162.00	42.00
80	15.22	209.00	82.00	211.00	65.00	216.00	76.00
90	19.97	249.00	107.00	251.00	87.00	264.00	113.00
100	24.56	287.00	133.00	289.00	108.00	312.00	151.00
110	28.97	319.00	157.00	322.00	130.00	348.00	183.00
120	32.90	351.00	177.00	353.00	150.00	375.00	214.00
130	36.59	380.00	194.00	382.00	168.00	397.00	245.00
140	39.95	405.00	209.00	408.00	182.00	414.00	274.00
150	42.99	427.00	222.00	430.00	195.00	429.00	298.00
160	45.72	445.00	235.00	447.00	207.00	441.00	319.00
170	48.15	461.00	247.00	464.00	217.00	452.00	335.00
180	50.60	476.00	258.00	479.00	227.00	459.00	349.00
190	52.93	491.00	268.00	494.00	236.00	466.00	361.00
200	55.19	504.00	276.00		244.00	472.00	371.00
210	57.35		283.00		252.00	474.00	380.00
220	59.39		290.00		259.00	474.00	389.00
230	61.35		296.00		266.00	474.00	396.00
240	63.22		301.00		271.00	473.00	402.00
250	65.0		307.00		275.00	472.00	408.00

(continued)

Table A-26. Timber volume tables for managed stands (cubic metres) (continued)

Table	58	59	60	61	62	63
Age	S/B/C/H G/M, 8+	S/B/C/H P, 8+	Pine G/M	Pine P	Pine G/M, 8+	Pine P, 8+
10	0.00	0.00	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00	0.00	0.00
30	2.00	0.00	19.00	1.00	26.00	0.00
40	19.00	0.00	64.00	15.00	80.00	9.00
50	68.00	1.00	119.00	40.00	134.00	32.00
60	133.00	8.00	164.00	71.00	182.00	56.00
70	199.00	23.00	210.00	101.00	235.00	86.00
80	254.00	49.00	251.00	123.00	273.00	108.00
90	309.00	80.00	283.00	145.00	307.00	128.00
100	352.00	113.00	310.00	163.00	334.00	146.00
110	383.00	147.00	333.00	186.00	355.00	162.00
120	407.00	175.00	350.00	205.00	372.00	181.00
130	427.00	202.00	364.00	221.00	386.00	198.00
140	443.00	228.00	377.00	234.00	398.00	213.00
150	457.00	256.00	387.00	245.00	408.00	223.00
160	467.00	280.00	395.00	255.00	416.00	233.00
170	476.00	299.00	402.00	263.00	424.00	242.00
180	484.00	317.00	408.00	271.00	429.00	250.00
190	484.00	330.00	414.00	277.00	432.00	256.00
200	485.00	342.00	419.00	283.00	434.00	262.00
210	485.00	352.00	420.00	289.00	437.00	267.00
220	485.00	361.00	421.00	294.00	439.00	272.00
230	484.00	369.00	422.00	298.00	441.00	276.00
240	483.00	376.00	423.00	301.00	443.00	280.00
250	483.00	382.00	424.00	303.00	444.00	284.00
260						
270						
280						
290						
300						

(continued)

A.6 Volume Estimates for Regenerated Stands

Table A-26. Timber volume tables for managed stands (cubic metres) (concluded)

Table	71	72	73	74
Age	Dry Fir Selection PA 16	Fir Wet PA 16	S/B/C/H PA 16	Pine PA 16
10	0.00	0.00	0.00	0.00
20	0.00	0.00	0.00	0.00
30	0.00	0.00	0.00	0.00
40	0.00	0.00	0.00	0.00
50	0.11	0.00	0.00	3.00
60	0.75	1.00	0.00	12.00
70	2.29	4.00	0.00	25.00
80	4.44	9.00	1.00	39.00
90	6.74	16.00	1.00	52.00
100	9.05	27.00	3.00	69.00
110	11.22	37.00	6.00	85.00
120	13.25	46.00	9.00	97.00
130	15.15	57.00	18.00	107.00
140	16.90	66.00	28.00	116.00
150	18.53	75.00	43.00	125.00
160	20.05	83.00	58.00	133.00
170	21.46	91.00	75.00	141.00
180	22.77	98.00	91.00	147.00
190	23.99	105.00	109.00	154.00
200	25.14	112.00	125.00	161.00
210	26.22	118.00	140.00	167.00
220	27.24	125.00	153.00	173.00
230	28.20	130.00	167.00	178.00
240	29.11	136.00	180.00	184.00
250	29.97	140.00	192.00	189.00
260				
270				
280				
290				
300				

Appendix B

Socio-Economic Analysis Background Information

B.1 Limitations of Economic Analysis

The socio-economic analysis portion of this report identifies employment and income impacts, changes in government revenues, and community impacts as a result of changes in the TSA's harvest levels over time. Some of the assumptions used in this report are as follows:

- **Employment multiplier.** Employment multipliers are used to estimate indirect and induced employment impacts of a change in direct industry activity. The calculation of employment multipliers is based on analytical assumptions and data collected at a specific time period. The multipliers reflect industry and employment conditions at that time and may not accurately reflect industry and employment conditions in the future.
- **Employment coefficient.** Employment coefficients are ratios of person-years of employment per 1000 cubic metres of timber harvested. These ratios are used to estimate employment levels associated with alternative harvest rates. This method of analysis assumes that the industry structure will be the same in the future as it is today. While reasonably accurate in the short term, employment coefficients may change in the future due to changes in market conditions, product mix or production technologies.
- **Timing of impacts.** Employment impacts are shown to occur simultaneously with a change in the harvest level. While this assumption is reasonably accurate for the harvesting sub-sector, employment estimates for the silviculture and timber processing sub-sectors may not be as coincidental. As well, indirect and induced impacts tend to occur over a longer period, as levels of business and consumer spending adjust to changes in harvest levels.
- **Operating thresholds of mills.** It is unlikely that impacts on timber processing employment due to changes in harvest levels will be in direct proportion to the harvest changes (i.e., a 10% change in harvest may not lead to a 10% change in timber processing employment). Impacts on timber processing employment are more likely to occur step-wise related to operating thresholds of mills. For example, if a mill's timber supply is reduced, its operating threshold is reached when the decrease in timber supply causes it to lay off a shift of workers or to close the mill, either temporarily or permanently. Conversely, if the timber supply to the mill is increased, a processing threshold is reached when the mill has to decide whether to add another shift of workers or new capacity to process the increase in timber supply. In both cases, the per cent change in employment in the mill would probably differ from the per cent change in the timber processed. Because mills have many different operating configurations, accurately predicting an individual mill's operating threshold is impossible. As a result, impact figures pertaining to employment in timber processing are best interpreted as size of change rather than as precise changes in employment levels.
- **Government expenditures.** Provincial government expenditures are more related to government policy and population levels than to industry activity. As such, expenditures on education, health care and other government services are assumed to remain unchanged despite changes to the harvest level and subsequent changes in government revenues from the forestry sector. However, provincial government expenditures would likely change if a community's population significantly changes. This would amplify the community impacts of losses or gains in forestry sector jobs.
- **Proportional harvest reductions.** Harvest reductions are assumed to be proportionately distributed among all licensees and all forms of tenure within the TSA.

B.2 Economic Impact Analysis Methodology

Data sources.

Data for the socio-economic analysis were obtained from several sources. Harvest volume and stumpage data are from the Ministry of Forests. Timber flow and employment data are from responses to questionnaires that were sent to licensees, operators and processing facilities in the TSA. Other general economic data are from BC STATS, the Ministry of Finance and Corporate Relations, Statistics Canada and local communities. Estimates of taxes paid by the forest industry are from PriceWaterhouseCoopers.

Person-year of employment.

The unit of measurement for employment is a person-year. A person-year of employment is defined as a full-time job, which lasts at least 180 days per year. Part-time jobs were converted to equivalent full-time person-years of employment.

To estimate employment and income impacts associated with changes in TSA timber harvest levels, the forestry sector was divided into three sub-sectors:

1. harvesting;
2. silviculture; and
3. timber processing.

Employment and income impacts were estimated in several steps. The first step was to assess current activity in each of the three sub-sectors. Then, indirect and induced employment and employment income impacts were estimated, using data from Ministry of Finance and Corporate Relations (1996) and Statistics Canada. Next, employment coefficients were calculated and then applied to the base case harvest forecast. Other indicators of the forestry sector's contribution to the provincial economy, such as government revenues and industry taxes were also calculated, using Ministry of Forests stumpage estimates and other data sources.

Employment - harvesting.

Direct employment in harvesting consists of all woodlands-related jobs including harvesting, log salvage, planning and administration functions and log transportation. The employment multipliers used in this analysis define activities such as road building or maintenance work as indirect employment rather than direct employment because the forestry sector and other basic sectors purchase these services.

Data on employment, place of residence and timber flows were obtained from responses to questionnaires that were sent to licensees and operators in the TSA. The information was then used to estimate employment averages associated with harvest changes and the proportion of residents versus non-residents who work in the TSA.

Two estimates of direct employment in harvesting were calculated:

1) TSA direct employment in harvesting consists of employees who are engaged in harvesting and related activities within the TSA and who reside in communities within the TSA; and

2) Provincial direct employment in harvesting consists of employees who are engaged in harvesting, as above, plus those workers who reside outside the TSA, but who come to the TSA to work in harvesting and harvesting-related activities.

The estimates of TSA and provincial direct employment in harvesting were used to calculate employment coefficients per 1000 cubic metres. These employment coefficients were then used to estimate harvesting employment associated with the different harvest levels in the base case forecast.

Employment - silviculture.

Silviculture employment consists of all basic and intensive reforestation activities, including surveys, site preparation, planting, fertilization, pruning and spacing. Silviculture employment data were collected from the Ministry of Forests and licensees whose tenures require post-harvest silviculture work. Most silviculture work is seasonal and silviculture employees usually only work part time during the year. Because of this, information on silviculture employment was converted into equivalent full-time person-years of employment. Respondents were also asked to estimate the percentage of their silviculture employees who resided within the TSA and outside the TSA.

As with the harvesting sub-sector, two estimates of direct employment in silviculture were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for silviculture employment in the same manner as the employment coefficients for harvest employment.

Employment - timber processing.

Information about employment, production and sources of timber was gathered from mills. Information was also gathered as to whether timber harvested from the TSA was processed within the TSA or outside the TSA. This information indicates the degree of dependence the mills have on timber harvested within the TSA. To estimate the share of processing employment supported by TSA timber, mill employment was prorated by the relative contribution of timber from the TSA to a mill's total timber requirement. For example, if 80% of a plant's timber supply is from the harvest of the TSA, then 80% of the employment in the plant would be attributable to the TSA harvest. Employment figures were also adjusted to reflect the residences of workers (i.e., those who lived within the TSA and those who lived outside the TSA). Employment in timber processing that is supported by chip by-products from milling operations was also similarly estimated .

As with the harvesting sub-sector, two estimates of direct employment in timber processing were calculated: one for the TSA and another for the province. These employment figures were used to calculate employment coefficients for timber processing employment in the same manner as the employment coefficients for harvest employment.

Indirect and induced employment estimates.

Indirect employment in the forestry sector refers to those who provide goods and services to firms directly engaged in the basic forestry sector (for example, those who build or maintain road for log transport). Induced employment refers to those who provide the goods and services purchased by employees who are directly and indirectly engaged in the industry (for example, those who work in retail outlets). Indirect and induced employment figures were calculated using TSA and provincial employment multipliers developed by the Ministry of Finance and Corporate Relations.

Two sets of employment multipliers were calculated for this report: a migration multiplier and a no-migration multiplier. The migration multipliers assume that displaced workers will leave the region, reducing total income in the region by their full wage. The no-migration multipliers assume that displaced workers remain in the area, at least in the short term, and unemployment and other social safety net payments temporarily offset some of the income loss. Using the no-migration multipliers diminishes the degree of induced impacts associated with a change in direct employment.

B.2 Economic Impact Analysis Methodology

The TSA and provincial employment multipliers used in the Kootenay Lake TSA analysis are shown in Table B1.

Table B-1. Employment multipliers, Lillooet TSA

Forestry sub-sector	Lillooet TSA migration multiplier	Lillooet TSA no-migration multiplier	Provincial (Interior) migration multiplier	Provincial (Interior) no-migration multiplier
Harvesting	1.39	1.26	2.14	1.80
Solid wood processing	1.40	1.24	2.29	1.93
Plywood	1.40	1.24	1.93	1.64
Pulp	1.46	1.41	3.02	2.48

Sources: Ministry of Finance and Corporate Relations. 1999. The 1996 Forest District Tables.
Ministry of Finance and Corporate Relations. 1996. A provincial impact estimation procedure for the British Columbia forestry sector.

Estimates of employment income.

Employment income was calculated using average income estimates for workers in the forest industry. Based on Statistics Canada data, the weighted average annual pre-tax income (less benefits) for forestry sector workers in 1999 was:

$46,956 for those working in logging and forestry services;
$44,980 for those working in solid wood manufacturing; and
$58,136 for those working in pulp and paper mills.

Those in indirect and induced occupations earned approximately $30,732. Income taxes were calculated based on marginal tax rates of 23–28% with one-third of the total income tax paid accruing to the province.

Employment estimates of alternate timber supply levels.

To estimate employment generated by alternative timber supplies, the forecast harvest level is multiplied by the calculated employment coefficients. Note that employment coefficients are based on current industry productivity, harvest practices and forest management assumptions and will not likely reflect industry operating conditions in future years. Therefore, the employment estimates should be viewed as indicators of size of change rather than as precise estimates of changes in employment levels.

B.2 Economic Impact Analysis Methodology

Provincial government revenues.

Except for stumpage, royalty and rents, which are specific to the TSA, provincial government revenue impacts were estimated by using industry averages. Revenues per 1000 cubic metres of harvest, expressed as dollars per 1000 cubic metres, were calculated and applied to the harvest levels in the base case forecast in a manner similar to how employment impacts were estimated (Table B2).

Table B-2 Estimates of provincial government revenues, Lillooet TSA

	Average annual revenue 997–1999 ($ millions)	Revenue ($ per '000 m^3)
Stumpage and related payments[a]	$5.1	$10,563
Forest industry taxes[b]	$3.6	$7,426
Employee income tax[c]	$4.4	$8,913
Total	$13.1	$26,902

[a] Source: Ministry of Forests, Revenue Branch.

[b] Based on estimates by PriceWaterhouseCoopers. Includes taxes for logging, corporate income, corporate capital, sales, property and electricity.

[c] Estimated from Revenue Canada income tax rates and includes only the provincial share of income taxes paid.